RADIO STATION Type KB-1

DESCRIPTION

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Chapter I

BASIC CHARACTERISTICS

1. Purpose

The power and frequency range of the station make it suitable for long-distance communication. For communication at distances of up to 100 - 200 miles it is recommended to use a less powerful station or to reduce the power of the transmitter of the KB-1 station with the aid of a special power control arranged on the control unit to the least value which ensures reliable reception.

The circuit and design of the radio station allow for group installation, i.e. installation in a radio centre together with other transmitters. When the receiver is installed together with the transmitter, both reception and transmission are conducted at the place of installation of the station.

2. Components

When operating from A.C. mains of 220/380 volts the transmitting radio station consists of the following units:

(a) transmitter;

(b) selenium rectifier, type BC-1;

(c) control unit together with handset and modulation assembly;

(d) crystal heating element;

(e) remote control posts: remote communication post and radio operator's post (RCP and ROP);

(f) amplifier and dynamic.

When operating from D.C. mains of 110/220 volts, in addition to the above equipment a power unit for converting direct current into alternating three-phase current of 220 volts is provided.

The power unit includes:

(a) converter, type П-7.2, with current-type voltage stabilizer;

(b) manual excitation control of generator, type P3B-21A;

(c) automatic control station, type СМЛ-2001 - $\frac{21A1}{22A2}$;

(d) switchboard.

The other power unit includes:

(a) converter, type ПТ-5;

(b) starter, type КРП-5;

(c) voltage control unit of generator, type БРКТ-5;

(d) carbon voltage control of generator РУН-121;

(e) manual excitation control, type РВ-5212;

(f) voltage control unit of generator, type БРШТ-5;

(g) selenium rectifier, type ВС-255;

(h) setting rheostat, type ВС-240;

(i) supply switchboard.

3. Frequency Range

The transmitter operates throughout a continuous frequency range of from 3 to 24 Mc/s (from 100 to 12.5 metres). Any frequency within this range can serve as the working frequency. The complete range of the transmitter is divided into 12 bands, the limits of which are given in Table 1.

Table 1

Bands	Limits in Mc/s	Limits in m.
1	3-3.5	100-85.71
2	3.5-4.2	87.71-71.43

Bands	Limits in Mc/s	Limits in m.
3	4.2-5	71.43-60
4	5-6	60-50
5	6-7	50-42.86
6	7-8.4	42.86-35.72
7	8.4-10	35.72-30
8	10-12	30-25
9	12-14	25-21.43
10	14-16.8	21.43-17.86
11	16.8-20	17.86-15
12	20-24	15-12.5

The bands are selected with the aid of a switch. When the switch is turned, the appropriate tuning components of the transmitter tuned circuits are switched over and simultaneously dials are changed. Thus the frequency within each band is set according to a dial corresponding to the given band.

4. Power Output of the Transmitter

The full r.f. power of the transmitter output stage is of the order of 1100 to 1500 watts. The power developed by the transmitter in the antenna is of the order of 500 - 1000 watts.

The transmitter is provided with a stepped manual power control. With the aid of the switch on the control unit it is possible to set the power of the transmitter to 100 per cent , 75 per cent, 50 per cent, 25 per cent and 5 per cent of the nominal value.

With the transmitter properly tuned, it is possible to regard the power in the antenna as characterized by the value of the power of D.C. anode current applied to the valves of the output stage.

The normal value of this power (with the switch set to 100 per cent) is about 1700 to 1800 watts, which corresponds to a normal anode current of the output stage valves of 600 to 700 mA.

5. Operation Modes of the Transmitter

The radio station is designed for operation throughout a continuous frequency range and is provided with a continuous frequency range oscillator. In addition to the

continuous range oscillator there is also a crystal oscillator designed for operation on crystal-controlled frequencies as well as for operation by the frequency-shift keying method from printing telegraph sets.

The circuit and design of the radio station provide for radio communication by one of the following operating modes:

(a) CW telegraphy;

(b) tone-modulated telegraphy;

(c) telephony;

(d) printing by the method of frequency-shift keying of the carrier frequency.

The principle operating modes are CW telegraphy at a keying rate of up to 20 groups per minute and telephony. Both these modes of operation can be conducted with simplex or semi-duplex communication directly from the place of installation of the transmitter or from the remote posts (remote communication post and radio operator's post).

The remote posts help to use the communication means of the ship most advantageously under combat conditions.

During manual telegraphy use is made of automatic semi-duplex operation which allows reception to be

conducted during pauses in transmissions; in telephone operation automatic switching from reception to transmission is achieved with the aid of the press-to-talk lever on the handset.

6. Types and Quantity of Valves

The transmitting radio station employs 27 valves, whose functions are given in Table 2.

Table 2

Function	Type of valve	Quantity
Continuous range master oscillator	ГУ-50 (П-50)	1
2nd stage	ГУ-50 (П-50)	1
3rd stage	ГУ-50 (П-50)	1
4th stage	ГУ-50 (П-50)	2
5th stage (output)	ГУ-50 (П-800)	2
Antenna circuit tuning indicator	6Х6	1
Modulation assembly	6А7 (6SA7) 6Ж8 6Х6	1 3 2
Frequency-shift keying crystal oscillator	6Ж7 6Н7 П-50	1 2 1

Description of the rectifier	Voltage, V	Current, A
Rectifier for anode circuit of master oscillator valve.....	220	0.05
Rectifier for screen grid circuits of П-50 transmitter valves....................	250	0.1
Rectifier for control and signalling circuits.........	24	4

The selenium rectifier are sensitive to overheating. At temperatures above 75°, the rectifying properties of selenium discs deteriorate. The BC-1 rectifier assembly is provided with special signalling system to warn the attending personnel of overheating. A red signal appears when the temperature increases above the permissible value. For prolonged operation, the rectifier is provided with forced-air exhaust ventilation.

C h a p t e r II

THE CIRCUIT DIAGRAM OF THE KB-1 TRANSMITTING RADIO STATION

1. General Block Diagram

The radio station is available in two supply system versions. Accordingly, both supply versions are shown in the general block diagram (Fig.1).

The ship's D.C. supply mains is fed via supply switchboard 1 to control equipment 2 and converter 3. From the converter the three-phase A.C. voltage is supplied to rectifier assembly 4. The rectifier assembly, which supplies all the transmitter circuits, is controlled with the aid of control unit ПУ 6, in the lower part of which is arranged a modulator. The control unit is connected via ship's switchboard 10 to radio operator's post 7 and remote communication post 8. The number of radio operator's posts and remote

communication posts and, consequently, the capacity of the switchboard are determined by the design of the ship. When operating from A.C. mains converter 3 and control equipment 2 with supply switchboard 1 are excluded. Ship's three-phase A.C. mains are wired directly to rectifier assembly 4.

The signalling and calling circuits of switchboard 10 are supplied from a 24-volt storage battery, as a result of which calls and communications between the remote posts, the switchboard and the control unit can be conducted with rectifier 4 switched off.

Remote post 8 can be supplied with a special amplifier and dynamic 9 which provide loudspeaker reception.

The antenna output of transmitter 5 is connected to antenna switchboard 12, which provides switching of the transmitting antennas A_1, A_2 and A_3.

2. The Block Diagram of The Transmitter

The transmitter consists of the following main units shown in Fig. 2:

(1) continuous range master oscillator;

(2) buffer-frequency doubler;

(3) crystal-oscillator;

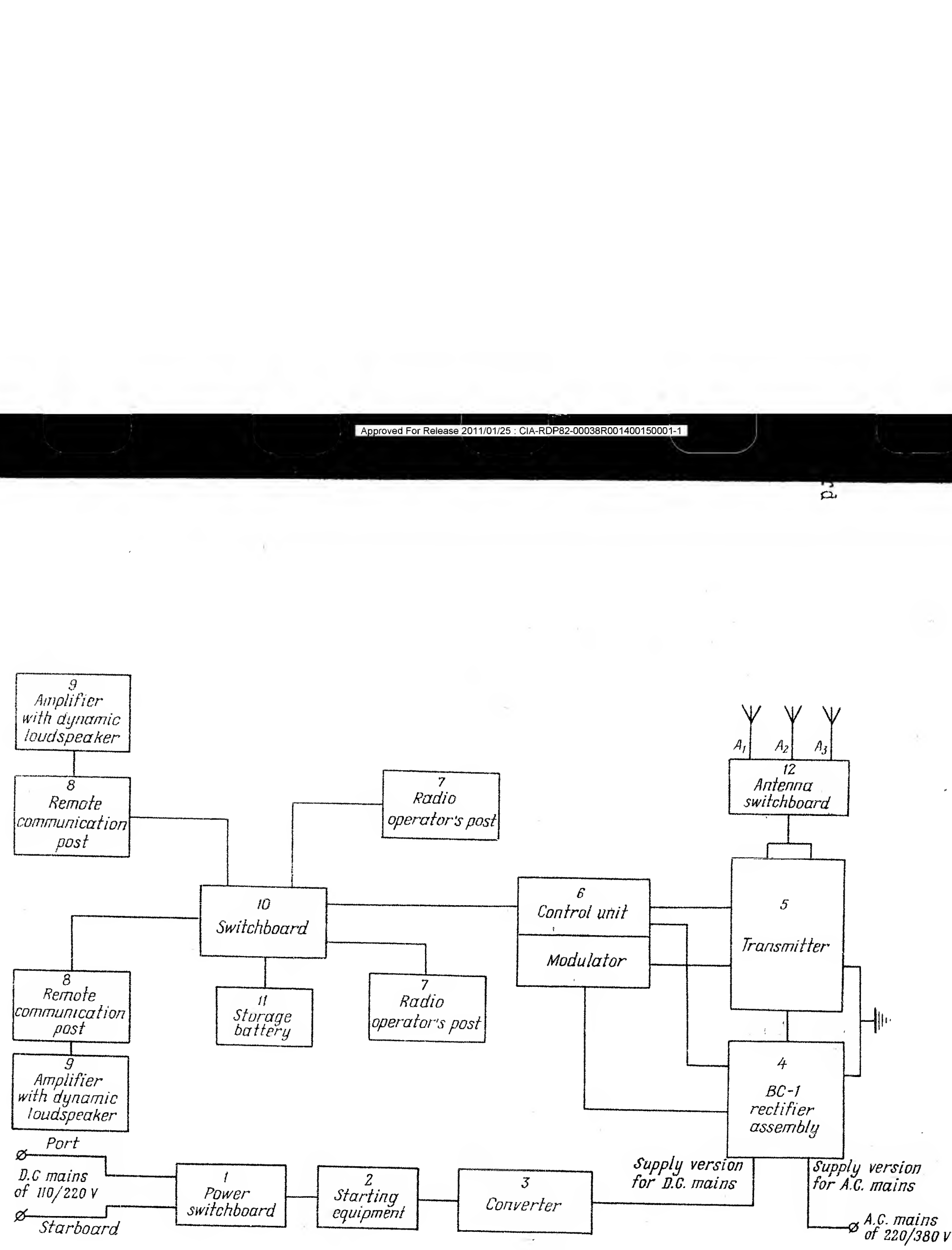

Fig.1. Block Diagram of the KB-1 Transmitting Radio Station

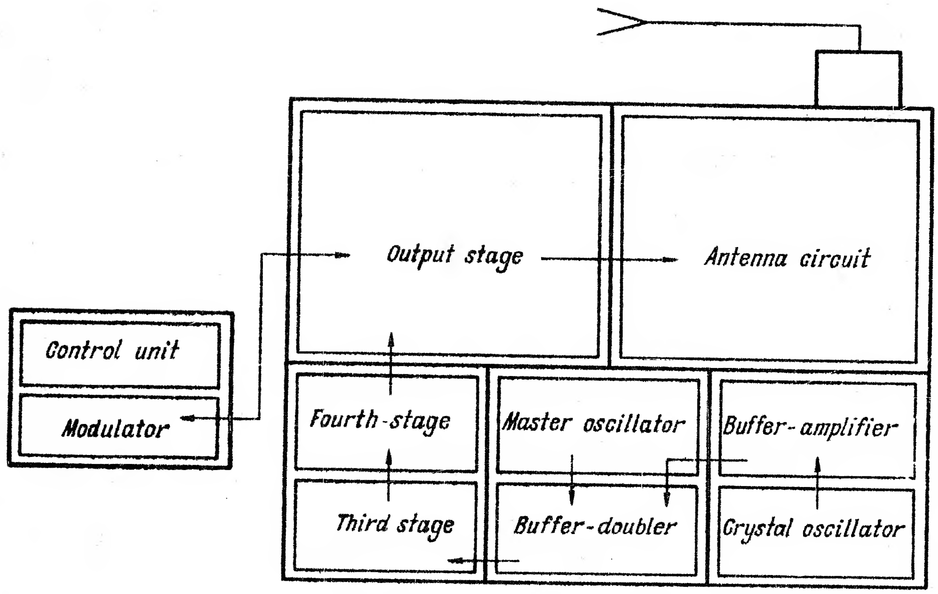

Fig. 2. Block Diagram of Transmitter

(4) buffer-amplifier of crystal oscillator;

(5) third transmitter stage;

(6) fourth transmitter stage;

(7) fifth (output) transmitter stage;

(8) antenna circuit.

These main units are arranged in Fig. 2 in such a way as to give an idea of their arrangement in the transmitter. Certain features of the transmitter circuit should be noted.

The transmitter covers the whole continuous frequency range of from 3 to 24 Mc/s in 12 bands given in Table 4.

The master oscillator and the second stage have only 4 bands (А,Б,В,Г) which are repeated 3 times when passing through the full range of the transmitter. The second stage always operates as a frequency doubler, as a result of which the range of the second stage is from 3 to 6 Mc/s.

The third stage operates throughout the range 3 to 6 Mc/s as an amplifier and within the range 6 to 12 Mc/s as a frequency doubler (second doubler of th the transmitter).

The fourth output stage operates within the range 3 to 24 Mc/s. Within the range 3 to 12 Mc/s it operates as an amplifier and within the range 12 to 24 Mc/s as a doubler(third frequency doubler).

The fifth output stage operates as an amplifier throughout the whole working range.

Thus due to frequency multiplication in the intermediate stages of the transmitter, the range of the master oscillator is within 1.5 to 3 Mc/s, which constitutes a frequency coverage of 2 while the frequency coverage of the transmitter output equals 8. This circumstance simplifies the design of the master oscillator tuning circuit, increasing frequency stability. With doubling in the subsequent stages, a lower frequency of the master oscillator can be chosen, which also makes for frequency stability.

Table 4

Band No.	Master oscillator	1st stage	2nd	3rd	4th	5th

Table 4

Band No.	Master oscillator band	1st stage	2nd stage	3rd stage	4th stage	5th stage
		Mc/s	Mc/s	Mc/s	Mc/s	Mc/s
1	А	1.5–1.75	3.0–3.5	3–6	3–6	3–6
2	Б	1.75–2.1	3.5–4.2	amplification	amplification	amplification
3	В	2.1–2.5	4.2–5			
4	Г	2.5–3	5–6 doubling			
5	А	1.5–1.75	3.0–3.5	6–12	6–12	6–12
6	Б	1.75–2.1	3.5–4.2	multiplication (2nd doubling)	amplification	amplification
7	В	2.1–2.5	4.2–5			
8	Г	2.5–3	5–6 doubling			
9	А	1.5–1.75	3.0–3.5	6–12	12–24	12–24
10	Б	1.75–2.1	3.5–4.1	multiplication	multiplication of frequency	amplification
11	В	2.1–2.5	4.2–5	(2nd doubling)	(3rd doubling)	
12	Г	2.5–3	5–6 doubling			

The use of frequency doubling in the intermediate stages of the transmitter makes for more stable operation of the transmitter, in respect of self-excitation, because the tuned circuits of the subsequent stages are tuned to different frequencies than those of the first stages.

The transmitter employs transmitting pentodes ГУ-50 and П-800. The use of a pentode in the master oscillator made it possible to employ an electron-coupled circuit which features greater stability than other circuits.

Continuous tuning of the transmitter circuits is achieved with the aid of variometers. The use of specially designed variometers in the master oscillator circuit made it possible to increase frequency stability considerably and at the same time to obtain an approximately linear tuning dial. The use of variometers made it possible to increase the frequency coverage of the circuits despite a relatively high initial capacitance of the circuit.

A simplified circuit diagram of the transmitter is shown in Fig. 3.

We shall examine the units of the circuit diagram separately.

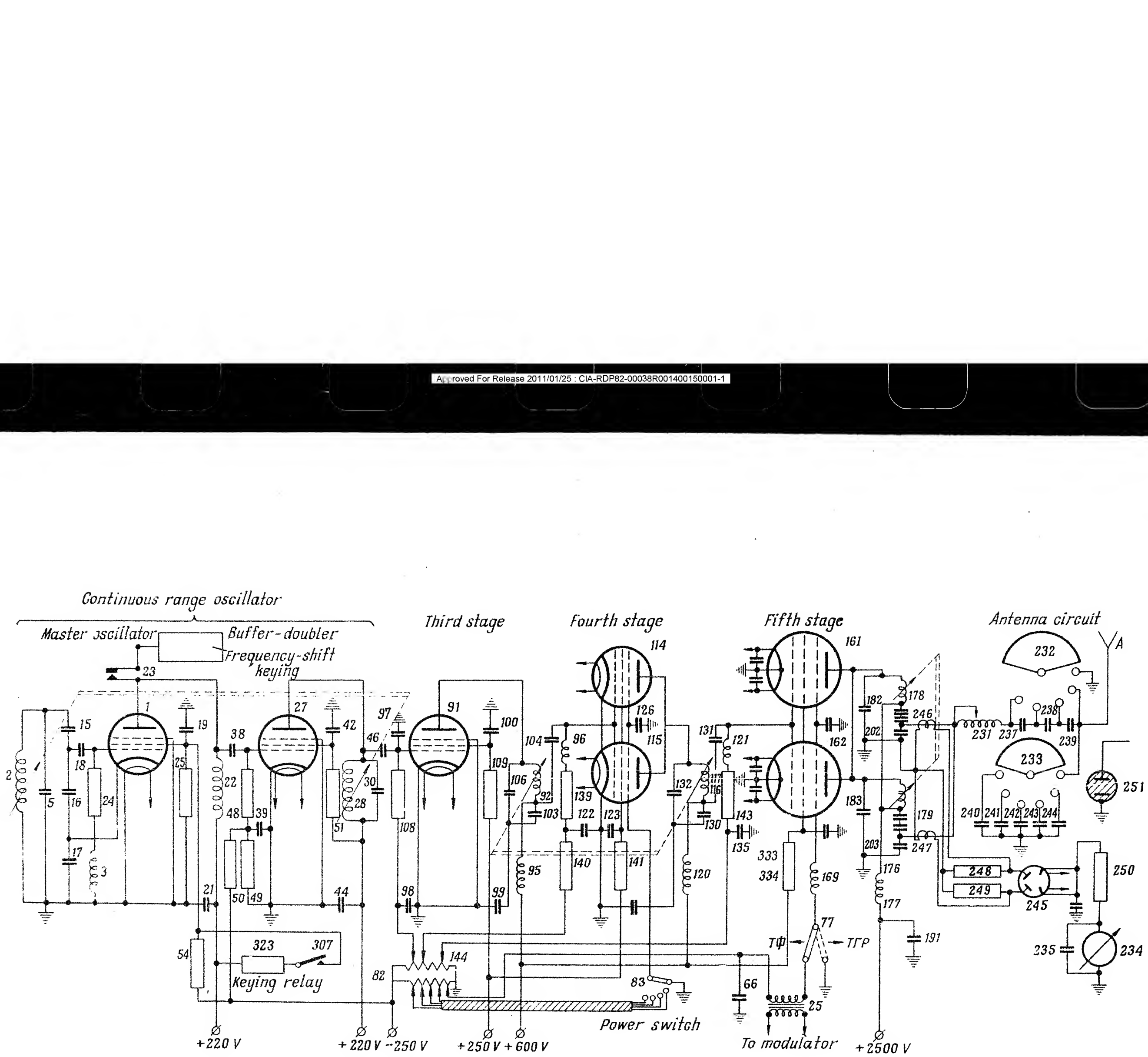

Fig.3. Simplified Circuit Diagram of Transmitter in Continuous Range Operation

3. Continuous Range Oscillator

The continuous range oscillator consists of two stages: the master oscillator and the buffer-doubler.

The master oscillator is that unit of the circuit which determines the frequency stability of the transmitter when operating in the continuous frequency range. A stable transmitter frequency is the main requisite for reliable searchless communication.

The main factors affecting the frequency stability of the master oscillator are:

(a) variation in the temperature of components;

(b) variation in the voltage of supply sources;

(c) effect of the subsequent, more powerful stages;

(d) mechanical deformation of components;

(e) variation in the ambient air humidity.

Suppressing these undesirable effects is an important problem in achieving frequency stability of the oscillator.

The choice of the master oscillator circuit is of great importance in the achievement of high stability. Of the widely used circuits with inductive and capacitive feedback, circuits with capacitive feedback should be preferred.

Such a circuit is shown in Fig.4.

Continuous tuning of this circuit is usually obtained with the aid of a variable inductance (variometer), because this makes it possible to select a sufficiently large value of tuned circuit capacitance, as a result of which relative variations in circuitry and valve capacitance will have little effect on frequency stability.

In the Colpitts circuit it makes no difference in principle which of the valve electrodes is earthed. As far as weakening of external influences is concerned it is advantageous to earth the anode, the electrode which has the largest area and is closest to the external earthed shield With the anode earthed, variation in the anode capacitance of the valve (C_9) with respect to the shield and other components of the circuit has practically no effect on the master oscillator frequency. The circuit with the anode earthed for radio frequencies, via the condenser C_p is shown in Fig.5.

An essentially new feature of the circuit is the use of cathode chokes L_∂. The chokes prevent radio frequency earthing of the second point (δ) of the circuit. In the case of indirectly heated cathodes, one choke L_∂ in the cathode circuit is sufficient. In the circuits

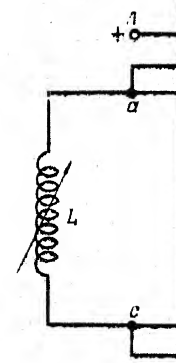

Fig.4. Ma
Cap

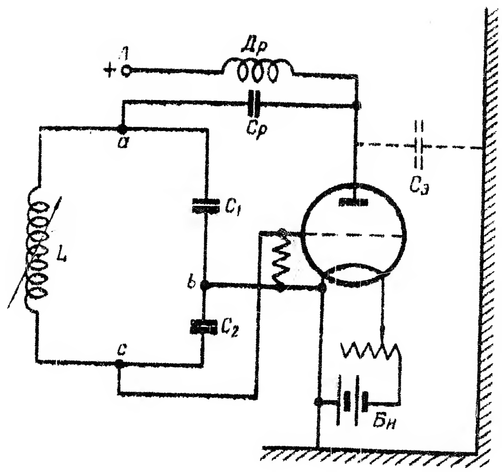

Fig.4. Master Oscillator with Capacitive Feedback

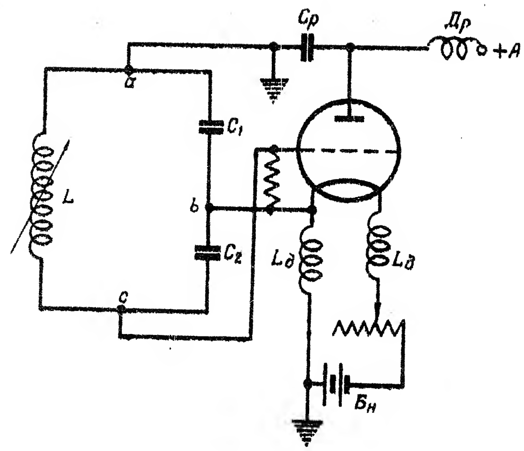

Fig.5. Master Oscillator with Earthed Anode

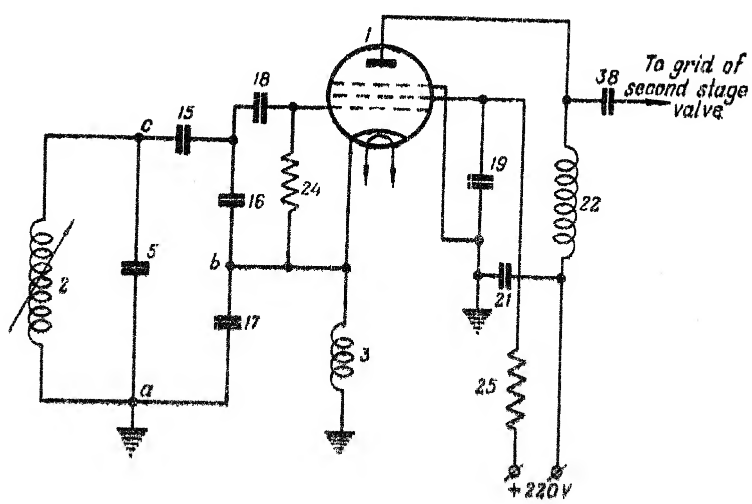

Fig.6. Circuit of Master Oscillator with Electronic Coupling

shown in Figs 4 and 5 the grid circuit of the subsequent stage must be connected directly to the tuned circuit of the master oscillator which affects frequency stability .

This circumstance made it imperative to use multi-grid valves, or pentodes. Such a circuit is shown in Fig.6. In this circuit the screen grid serves as the earthed anode of the ordinary Colpitts oscillator. The value of feedback is determined by the relationships between capacitances 15, 16 and 17 which together with inductance 2 and condenser 5 form the so-called inner circuit. The earthed screen ogrid (via condenser 19) and the suppressor grid eliminate harmful capacitive coupling between the inner circuit and the external load circuit.

The only coupling between the inner circuit and the external load (choke 22) is by way of the electronic stream itself that is why such circuits are called electron-coupled circuits. An advantage of this circuit is the relatively low adverse effect of the subsequent stages on the generated frequency. With a view to decreasing still further the effect of the subsequent stages, the anode circuit of the master

oscillator valve contains an untuned load, radio frequency choke 22. Such is the circuit employed in the master oscillator of the transmitter.

One of the significant factors affecting the frequency stability is the heating of the valves and components of the master oscillator. In order to decrease the effect of this factor, the master oscillator valve operates under very light conditions. In addition, the valve is not connected directly to the tuned circuit but via a capacitance divider consisting of condensers 15, 16 and 17. As a result a coupling of the valve to the circuit and its influence on the parameters of the circuit are weakened.

The capacitance of the tuned circuit and the value of coupling of the valve to the tuned circuit on each band is selected so that the action of the valve on the circuit would remain approximately equal for all bands.

With a view to compensating partially the variation in frequency caused by heating of the valve, the capacitive divider employs ceramic condensers having a small negative temperature coefficient of capacitance (TCC). Heating of these condensers by the radio frequency currents passing through them decreases their capacitance, whereas the heating of

valve electrodes increases interelectrode capacitance. As a result the change in frequency of the operating oscillator is compensated, remaining relatively small.

Changes in ambient temperature varies the temperature of the master oscillator circuit components. This produces a change in their geometric dimensions and, consequently, a change in their electrical parameters, which makes the frequency of the master oscillator unstable. In order to decrease variation in frequency with variation of the ambient temperature, the tuned circuit of the master oscillator is provided with heat compensation on all four bands. The use of a variometer on a ceramic former with a shorted turn in the circuit allows for a simple method of obtaining heat compensation in the continuous range, with very low deviation throughout the range.

For the purpose of heat compensation, the circuit capacitors are selected from three different groups of ceramic condensers: group Ж having a high negative TCC (of the order of -700×10^{-6}), group C having a positive TCC (of the order of $+100 \times 10^{-6}$), and condensers of group M for the capacitive divider, which have a small negative TCC (-50×10^{-6}). The capacitance

of the tuned circuit is formed by high capacity condenser 5 of group C and by three or four, and occasionaly even more, small condensers of the group K and C connected in parallel to the main condenser. The capacitances of these small condensers are specially selected so that the temperature coefficient of frequency of the master oscillator would be within from $+5 \times 10^{-6}$ to $+7 \times 10^{-6}$.

This circumstance should be taken into account during repairs, as well as the fact that the inner plate of each ceramic condenser should be connected to points of the circuit with higher radio frequency potential, while the outer plate to points of the circuit with lower potential or to the shield. When the latter condition is fulfilled, the distributed capacitance of the circuit with respect to earth is at minimum value and parasitic frequency modulation of the transmitter tone caused by mechanical vibration affecting the components is insignificant.

With slow variation in ambient air temperature during 20 - 30 minutes, different heat conductivity of different components can cause the latter to heat ununiformly thus,disturbing heat compensation. In this case frequency variation can reach a considerable value. In order to eliminate this undesirable effect,

as well as to decrease the action of the ambient temperature on the frequency, the tuned circuit of the master oscillator is housed in a thermostat. The presence of air heated to 60° inside the thermostat helps to protect the tuned circuit from the air humidity inside the radio station.

In order to decrease the action of the supply voltages on the frequency of the master oscillator, all the supply voltages of the master oscillator valve are stabilized.

The input impedance of the valve of any transmitter stage does not remain constant but changes according to the operating conditions of the valve. These changes can affect the frequency of the master oscillator, especially in those cases when the stage following the master oscillator is fairly powerful. In order to eliminate this harmful effect the master oscillator is followed by a buffer stage.

The second stage of the continuous range oscillator (the second stage of the transmitter) employs transmitting pentode 27, type ГУ-50 (Fig.3) in the circuit of a valve oscillator with independent excitation.

The oscillating voltage from anode choke 22 of master oscillator valve 1 is fed via blocking

condenser 38 to the grid of second stage valve 27. In order to ensure constant operating conditions, the control grid of valve 27 is supplied with combined bias: external from a special rectifier and self-bias developed by the grid current passing through resistors 48 and 49.

The bias is selected so that when alternating excitation voltage is applied from the master oscillator to the control grid of valve 27, the resultant voltage remains mostly in the region of negative values and the valve operates with low grid currents.

Due to weak coupling of the master oscillator to the grid circuit of the second stage valve and the operation of the latter with low grid currents in the frequency doubling mode, the action of subsequent more powerful stages on the master oscillator is reduced. For this reason the second stage is called a buffer-doubler.

The anode circuit of the second stage valve includes a tuned circuit, consisting of variometer 28 and condenser 30 (Fig.3), which is always tuned to the doubled frequency of the master oscillator. Control of variometer 28 is mechanically ganged with the control of master oscillator variometer 2. Thus

the first and second stages of the continuous range oscillator are tuned by means of one knob.

4. Crystal-Controlled Frequency-Shift Keying Oscillator

Frequency-shift keying of the radio transmitter is obtained through the action of telegraph signals on the frequency of the crystal oscillator. The transmitter crystal oscillator (Fig.7) employs a coilless circuit in conjunction with an electron-coupled oscillator circuit based on pentode valve 262, type 6K7.

The screen grid of valve 262 serves as an anode at zero radio frequency potential. The cathode circuit of the valve includes choke 278 the purpose of which is to prevent radio frequency shunting of capacitor 279. The load in the anode circuit is resistor 285. From resistor 285 excitation voltage is applied via blocking condenser 299 to the grid of valve 300 of the second crystal oscillator stage. If the crystal is replaced by its equivalent circuit, the circuit diagram of the crystal oscillator will appear as shown in Fig. 8.

This is the circuit of an ordinary oscillator with capacitive feedback. In parallel with the

crystal, which serves as a tuned circuit, is connected a capacitive voltage divider consisting of condensers 281, 279 and 283. Feedback is obtained by applying the voltage from condenser 283 to the grid of valve 262.

The operating conditions of the circuit are selected so that the current in the crystal circuit is low. This decreases heating of the crystal and, consequently, increases its frequency stability. This accounts for the fact that crystal oscillators employing the given circuit are usually made low powered.

If a reactance (inductance or capacitance) is connected in series or parallel with the crystal, the frequency of the oscillator will have to change, because the natural frequency of the oscillatory circuit equivalent to the crystal and connected between points a and b will change. The crystal will now oscillate at a frequency differing somewhat from its natural resonant frequency.

Frequency-shift keying of the crystal oscillator of the radio transmitter is obtained by shorting and unshorting choke 265 (Fig.9) with the aid of keying relay 298, according to the signals being transmitted.

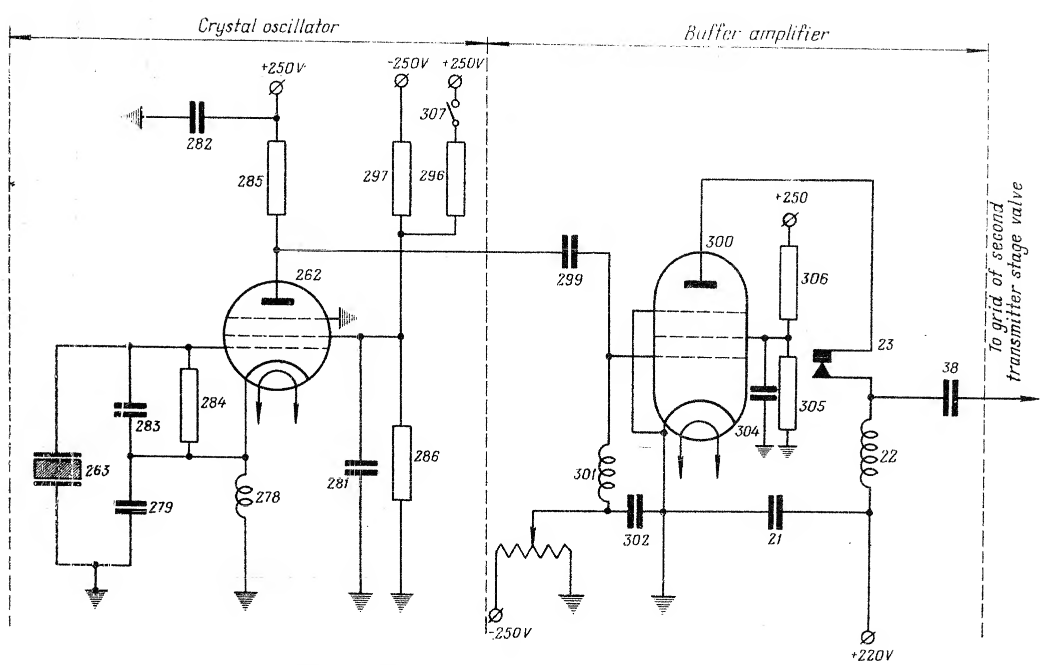

Fig. 7. Circuit Diagram of Crystal Oscillator and Buffer Amplifier

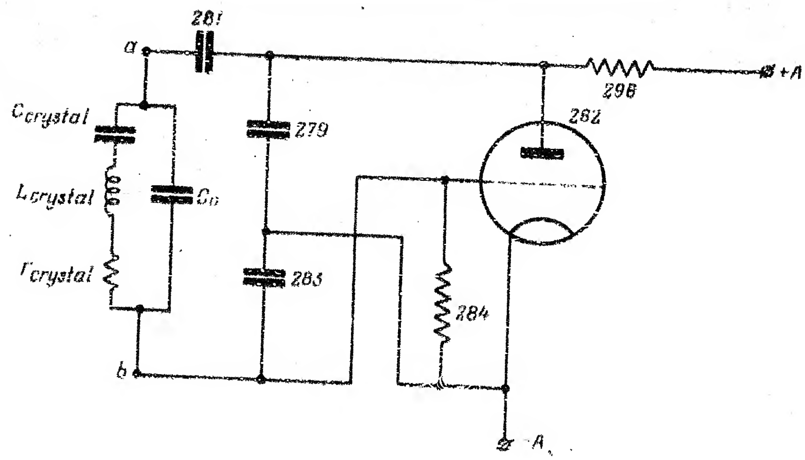

Fig. 8. Equivalent Circuit of Coilless Crystal Oscillator

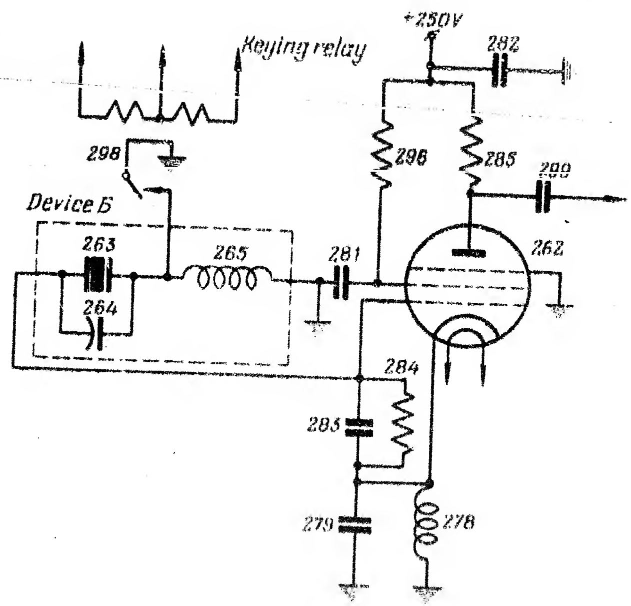

Fig. 9. Circuit Diagram of Frequency-Shift Keying of Crystal Oscillator

During the inter-signal pauses the relay contacts are closed and the natural frequency of the oscillator is generated. This corresponds to the spacing frequency f_{sp}. When working pulses are transmitted, the contact of relay 298 opens, choke 265 is connected in series with the crystal circuit, and the oscillator frequency decreases by the value of the frequency shift. In this case the generated frequency corresponds to the signal frequency f_s. The value of the frequency shift is determined by the inductance of choke 265 and the frequency of crystal 263. For this reason the crystal and the corresponding deviation choke are housed together in a replaceable unit known as device Б. Device Б also includes trimmer 264 which is connected in parallel with the crystal and serves for fine adjustment of the crystal oscillator frequency to the nominal value. The inductance of choke 265 and the capacitance of condenser 264 are adjusted at the works to a high degree of accuracy, after which device Б is closed and sealed.

In order to obtain high-frequency stability, device Б is housed in a thermostat which maintains a constant temperature of $+60^{\circ}$ with an accuracy within $\pm 1^{\circ}$. The temperature in the thermostat is

controlled with the aid of a mercury thermal relay similarly to the way this is done in the thermostat of the continuous range master oscillator.

The crystal oscillator of the radio transmitter is designed for operation throughout a frequency range of from 1.5 to 3.0 Mc/s.

The natural frequencies of the crystal are within this range.

The second stage of the crystal oscillator (See Fig. 7) is an amplifier and serves as a buffer, employing pentode 300, type П-50. The anode load of the second stage of the crystal oscillator is choke 22 from which the frequency voltage is applied via blocking condenser 38 to the control grid of valve 27 of the buffer stage of the continuous range oscillator, which always operates as a frequency doubler; in this way crystal frequencies are obtained within the range of 3 - 6 Mc/s.

The accuracy of setting and maintaining frequency on the fixed crystal frequencies is considerably higher than in the continuous range. For this reason the crystal oscillator can serve as a standard for checking the frequencies of transmitters and receivers.

The maximum possible deflection of the frequency from nominal value of the normally operating crystal oscillator does not exceed ± 25 to 30×10^{-6} or ± 0.0025 to ± 0.003 per cent.

The keying relay of oscillator 298 is a polarized relay with neutral adjustment. This type of relay requires a change in the direction of current in the winding to pull the armature from one contact to another.

In order to make keying possible from any telegraph set regardless of whether it transmits current pulses of one direction or two directions, the keying relay is not connected directly but via an intermediate electronic relay.

The electronic relay used by the frequency-shift keying oscillator is a D.C. amplifier employing double triodes 290 and 287, type 6H7 (Fig.10).

Keying relay 298 has two identical windings W_1 and W_2 connected in series. In order to hold the relay armature at a certain contact it is necessary for current to flow through only one relay winding in a certain direction. In order to switch the armature to the other contact it is necessary for the current in the previously operating winding to stop and at the same time for current to appear in the other winding.

In the given circuit, switching of the current in the windings is obtained by connecting the windings into the anode circuits of valve 287. The triodes of valve 287 operate by turns. When the left triode is cut off, the right triode conducts, its anode current flows through the winding W_2, causing the armature of the keying relay to be attracted to the right contact; conversely, when the right triode is cut off, the left conducts, and current flows through winding W_1, causing the armature to be attracted to the vacant left contact.

When positive voltage is applied to the input of the electronic relay, the left triode of valve 290 opens, because its grid is supplied with a positive voltage exceeding the value of the cut-off voltage E_{go}. The anode current flowing through the left triode of valve 290 causes a voltage drop to be developed across resistor 292 and correspondingly decreases the voltage at the anode of the left triode of valve 290. The current in the circuit of resistors 294 and 295 decreases. The value of the voltage drop across resistor 295 becomes less than the negative voltage E_c. For this reason the right triode of valve 290 and the left triode of valve 287 are cut off, because their grids are

Fig.11. Si

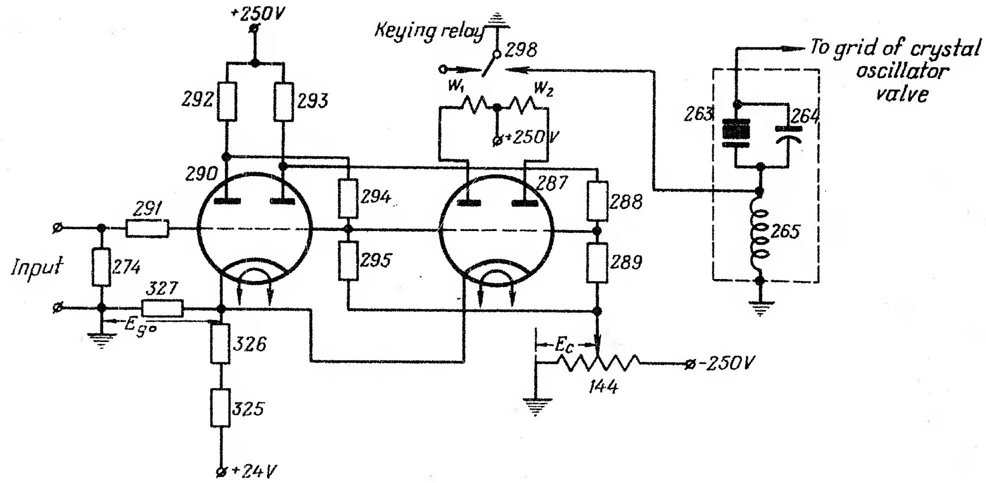

Fig.10. Circuit of Electronic Relay of Frequency-Shift Keying Oscillator

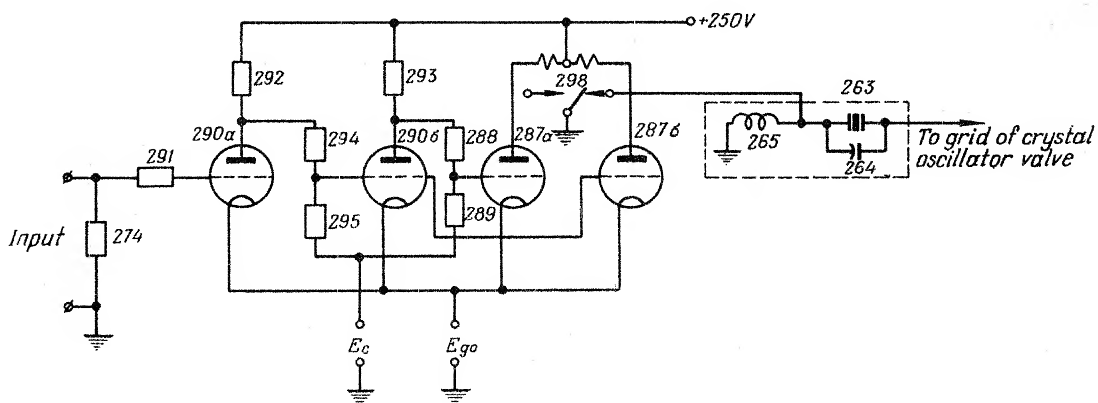

Fig.11. Simplified Circuit Diagram of Electronic Relay of Frequency-Shift Keying Oscillator

connected together. Current no longer flows through the right triode valve 290, the voltage drop across resistor 293 decreases and the voltage at the anode of the right triode increases accordingly. As a result the current in the circuit of resistors 288 and 289 increases, the voltage drop across resistor 289 becomes greater then the value of the cut-off voltage E_c and the right triode of valve 287 opens. Current flows through the winding W_2, the relay armature switches to the right contact, and as a result deviation choke 265 of device Б is short-circuited and the transmitter operates at the spacing frequency, i.e. at frequency f_{sp}.

If there is no voltage at the input of the electronic relay, which corresponds to the working pulse, the left triode of working valve 290 is cut off and the right triode conducts. At the same time the left triode of valve 287 conducts and the right triode is cut off. Current flows through the winding W_1, the relay armature is switched to the vacant left contact, the deviation choke is switched into the crystal circuit, and the transmitter operates at the signal frequency, i.e. at frequency f_s.

connected in parallel. The anode load of the valve is a tank circuit consisting of two variometers 116 and 117, trimming inductance coils (not shown in the diagram)and a group of fixed condensers conventionally shown in Fig. 3 by one condenser 132. All the tank circuit components are switched for the bands (for details See Chapter IV).

In the first and second bands the fourth stage operates as an amplifier, and in the third band as a frequency doubler.

D.C. anode voltage of +600 volts is supplied via choke 120 which protects the supply circuits from radio frequency currents.

Excitation voltage is supplied to the control grid of the fifth output stage valve from coupling condenser 130 connected into the inductive leg of the tank circuit in series with variometers 116 and 117,via blocking condenser 131.

Bias for the control grids of valves 114 and 115 is obtained in the same way as in the third stage, i.e. constant bias voltage is supplied by potentiometer 144 and, in addition, self-bias is developed by the grid current voltage drop across resistors 139 and 140. Supply voltage of +250 volts for the screen grids of the fourth stage valves is supplied via dropping resistor 141.

Negative voltage is supplied to the suppressor grids of the fourth stage valves from potentiometer 82. This voltage can be adjusted throughout a wide range with the aid of switch 83. The greater the negative bias on the suppressor grids, the lower the anode current of the fourth stage valves, and the lower the value of the oscillating voltage across the tank circuit of the fourth stage. Accordingly, the excitation voltage applied to the control grid of the fifth stage valve varies throughout a wide range and so does the power developed by the fifth stage. Thus, by varying the negative voltage at the suppressor grids of valves 114 and 115, it is relatively simple to vary the power output of the transmitter.

7. The Fifth Stage of the Transmitter

The fifth stage (Fig.3) is the transmitter output stage, which works into the antenna. This stage ensures the required radio frequency power in the antenna and is a powerful valve oscillator with independent excitation employing two transmitting pentodes 161 and 162, type ГУ-80. The valve anodes are series fed.

The anode circuits of the ГУ-80 valves include two tank circuits operating in parallel. Each tank circuit consists of a variometer, trimming inductance

coils, capacitive antenna coupling potentiometer, the output capacitance of the valve, trimming condensers, and variable condensers. In Fig.3 the tank circuits of the output stage valves are shown conventionally consisting of inductances 178 and 179, condensers 182 and 183 and antenna coupling condensers 202 and 203. Actually the tank circuits are considerably more complex than shown in Fig.3 (for details see Chapter IV).

On all bands the fifth stage operates as an amplifier.

The use of two tank circuits as the load of the anode circuits of the output stage simplifies the problem of adapting the transmitter for operation with symmetrical coastal antennas.

Fig.12 gives a simplified circuit diagram of the output stage of the transmitter intended for operation with a non-symmetrical antenna circuit. Here the output stage features parallel connection of two valve oscillators operating into a common antenna load.

Fig.13 gives the circuit diagram of the output stage with a symmetrical output.

Comparison of the two diagrams shows that switching over to a symmetrical output circuit can be achieved

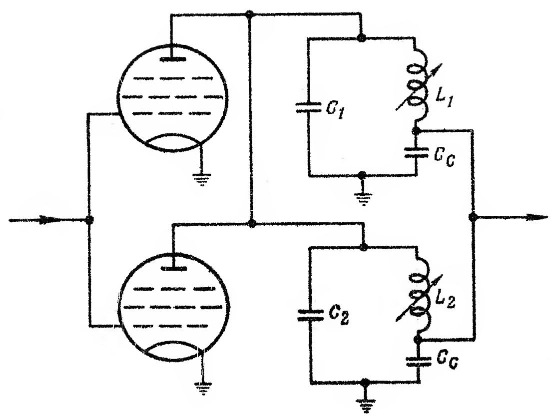

Fig.12. Circuit of Power Output Stage

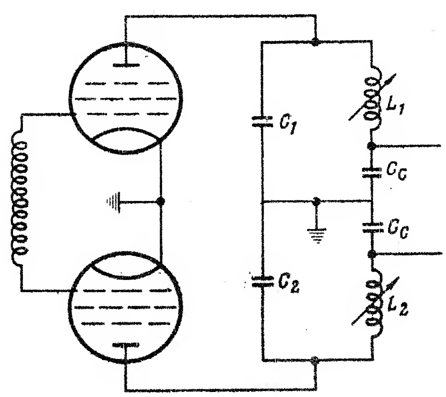

Fig.13. Circuit of Power Stage with Balanced Output

by applying anti-phase voltage to the control grids of the output stage and removing the wire connecting the valve anodes. As a result an ordinary push-pull circuit is obtained. D.C. anode voltage of +2500 volts is supplied by chokes 176 and 177 (Fig. 3). These chokes and by-pass condenser 191 protect the supply circuits from radio frequency currents.

Radio frequency voltage for supplying the antenna circuit is taken from coupling condensers 202 and 203 which are a group of series-connected condensers which form a capacitive potentiometer.

With the aid of a special switch it is possible to vary the value of the voltage supplied to the antenna circuit, i.e. to regulate the value of coupling with the antenna circuit. The bias for the control grids of the output stage valves is of the combined type and similar in circuit to that of the third and fourth stages. The screen grids of valves 161 and 162 are supplied with +600 volts from a rectifier via resistors 333 and 334, the purpose of which is to limit screen grid current.

Telephone operation is provided by amplitude modulation of the radio frequency oscillations in the fifth stage. Modulation is obtained through the action of audio frequency voltage on the suppressor grids of valves 161 and 162.

In CW telegraphy the suppressor grids of valves 161 and 162 are at zero potential (earth potential); in telephone operation and tone modulated operation these grids are supplied with a negative voltage of about 190 volts from potentiometer 82 via the winding of modulator output transformer 25.

8. The Antenna Circuit of the Transmitter

The antenna tank circuit of the transmitter serves for tuning the antenna circuit to the given working frequency. The antenna circuit is coupled to the tank circuits of the output stage by means of capacitive potentiometers 202 and 203, which provide stepped coupling control. The use of capacitive antenna coupling has been chosen in view of the following consideration. The output stage valves of a transmitter usually operate under conditions when the shape of the output current is distorted. In this case the anode current contains, in addition to the D.C. component and fundamental frequency current, also the A.C. current of higher frequencies which are multiples of the fundamental frequency, i.e. the second, third and other harmonics. Currents of these frequencies enter the antenna circuit, and their energy is radiated

by the antenna. The power of the harmonics is not great since the tank circuits are tuned to the fundamental frequency, however the harmonics can cause considerable interference for nearby receivers. As yet there is no way of eliminating the radiation of harmonics completely but it is possible to resort to a number of measures which may possibly weaken the interference caused by harmonics. One of these measures is the use of capacitive coupling between the antenna circuit and the intermediate circuit (the anode circuit of the fifth stage).

The improvement in the filtration of the harmonics achieved by the use of capacitive coupling is due to the fact that the reactance of the coupling elements (condensers) decreases with an increase in the number of the harmonics, i.e. with an increase in frequency. For very high frequencies, the coupling condenser is a short circuit.

The selection of suitable coupling between the antenna and intermediate circuits is an important step in the tuning of the output stage.

Often the operator attending the transmitter, in increasing the power output into the antenna, increases excessively the coupling of the antenna circuit to the intermediate circuit. In most cases this brings about

overheating of the anodes and failure of the valves. The most profitable operating conditions for the output stage (the so-called critical operating conditions) can be set up at a certain optimum coupling of the intermediate circuit to the antenna circuit, which must be selected during tuning.

With optimum coupling, the power in the antenna will be the greatest, and the heating of the anodes of the output stage valves will not exceed the permissible value.

In order to provide wide-range adjustment of the antenna coupling and to ensure tuning to various ship's antennas, the transmitter employs an antenna circuit of a complex design.

The antenna circuit consists of a continuous tuning element; it is formed by variable inductance coil 231 and the group of fixed condensers 237 - 244, which are connected in series and parallel with the antenna with the aid of switches 232 and 233.

Switch 232 switches condensers 237, 238 and 239, while switch 233, condensers 240 - 244.

The need of using a complex antenna circuit is due to the following. The antenna is a tuned circuit connected to the antenna circuit of the transmitter. Such a load presents an impedance, i.e. it consists of

resistive and reactive components. In order to transmit the maximum power from the intermediate circuit (the anode tank circuit of the fifth stage) to the antenna, the whole system consisting of the antenna and the antenna circuit must be tuned to resonance.

When the antenna is used throughout a wide-frequency range, its impedance varies throughout a wide range in both magnitude and sense. In order to ensure tuning to resonance within the working range, the antenna circuit must allow wide variation of its parameters. With low values of antenna impedance series connection of the condensers should be used; with high impedances it is necessary to use parallel connection. At medium values of antenna impedance, a combined antenna feed circuit may be used, i.e series and parallel connection of condensers.

If parallel and series connection of condensers is used simultaneously then the coupling of the antenna proper to the antenna circuit of the transmitter varies within a wide range and in this way provides additional possibility of regulating the value of the load of the output stage valve.

For checking the tuning of the antenna circuit, the transmitter circuit provides two types of

indicators: pointer-type instrument 234 with diode rectifier 245 and neon lamp 251. The circuit of the pointer-type instrument is inductively coupled to the antenna circuit with the aid of special transformers 246 and 247. The readings of the pointer-type instrument are proportional to the current in the antenna when the latter is series fed. When the antenna is parallel fed, the readings of the instrument are proportional to the current in the antenna circuit and the looser the coupling of the antenna to the antenna circuit, that is, the higher the capacitance of the parallel connected condensers, the higher is the reading of the instrument, the higher the power lost in the antenna circuit, and the lower the power transmitted to the antenna. This circumstance should be borne in mind when tuning the transmitter to the antenna.

In order to decrease the dependence of the indicator readings on frequency, the windings of the coupling transformers are shunted by low-valued resistors 248 and 249.

Neon lamp 251 is an additional tuning indicator of the antenna circuit. The brightness of the neon lamp varies considerably throughout the range due to variation in the voltage across the antenna circuit,

and at certain points of the range the neon lamp may stop glowing altogether despite the fact that the transmitter is tuned and feeding full power into the antenna.

The presence of two complementary tuning indicators ensures correct tuning of the transmitter to various types of antennas throughout the working frequency range.

Correct tuning of the antenna circuit is indicated by brightest glow of the neon lamp or maximum deflection of the pointer of instrument 234.

9. Modulation Assembly

Modulation is obtained in the transmitter by varying the voltage of the suppressor grids of the output stage valves, type ГУ-80. With constant voltage at the other electrodes of the valve, the value of the first harmonic in the anode current and, consequently, the value of the antenna current, depends on the suppressor grid voltage of the valve, as shown in Fig. 14.

The curve abc shown in Fig.14 is known as a static modulation curve. As seen in the drawing, within the linear section of the curve from point a to point C, the

amplitude of the first harmonic of the anode current I_{a1} varies proportionally to the variation in the voltage on the suppressor grid E_{g3}. This means that when the modulating voltage U_{Ω} at the suppressor grid varies with respect to the constant value of the bias voltage E_{g30}, there will be a corresponding variation in the envelope of the R.F. antenna circuit.

The modulation assembly of the radio station consists of the following main elements:

(a) modulator;

(b) automatic gain control (AGC);

(c) modulation depth indicator;

(d) tone generator with monitoring stage.

Modulator

The main purpose of the modulator consists in amplifying the audio frequency voltage developed by the microphone to a value sufficient for obtaining deep and distortionless modulation. The modulation should ensure normal operation from an input voltage of about 0.1 volts. Thus the overall amplification of the modulator is about 1200. Despite the use of negative feedback, which reduces the overall gain ten times, this amplification is obtained by three stages of the main modulator circuit. A simplified circuit diagram of the modulator is shown in Fig.15.

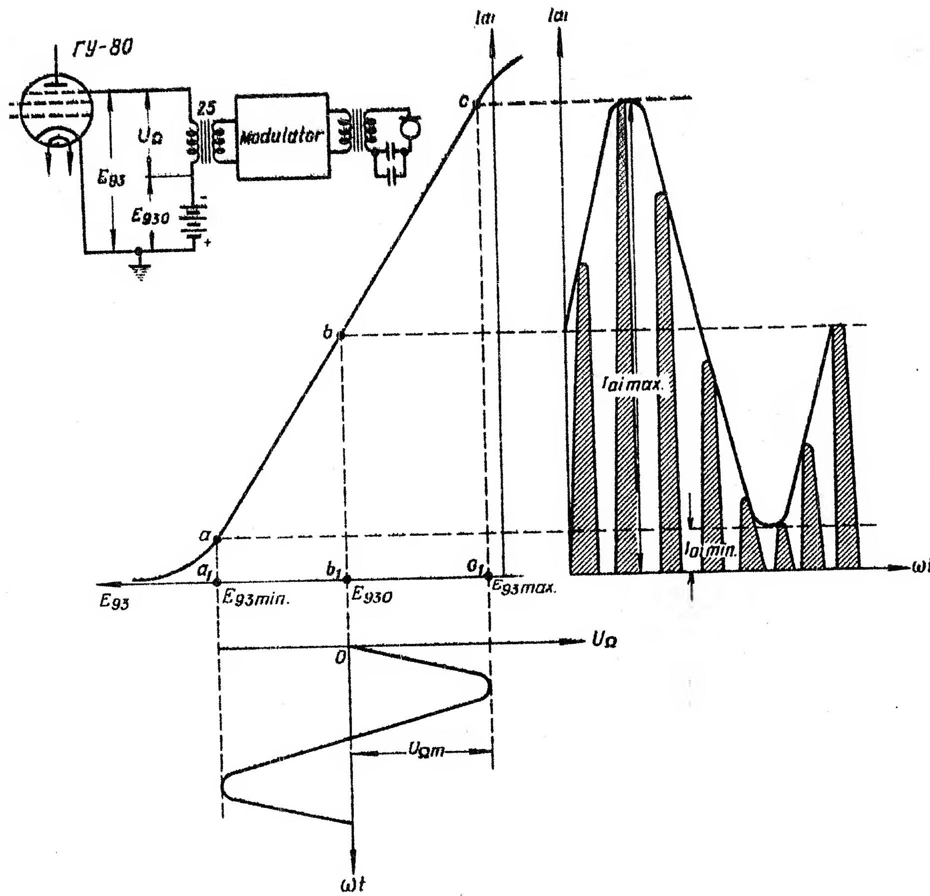

Fig. 14. Static Modulation Gurve

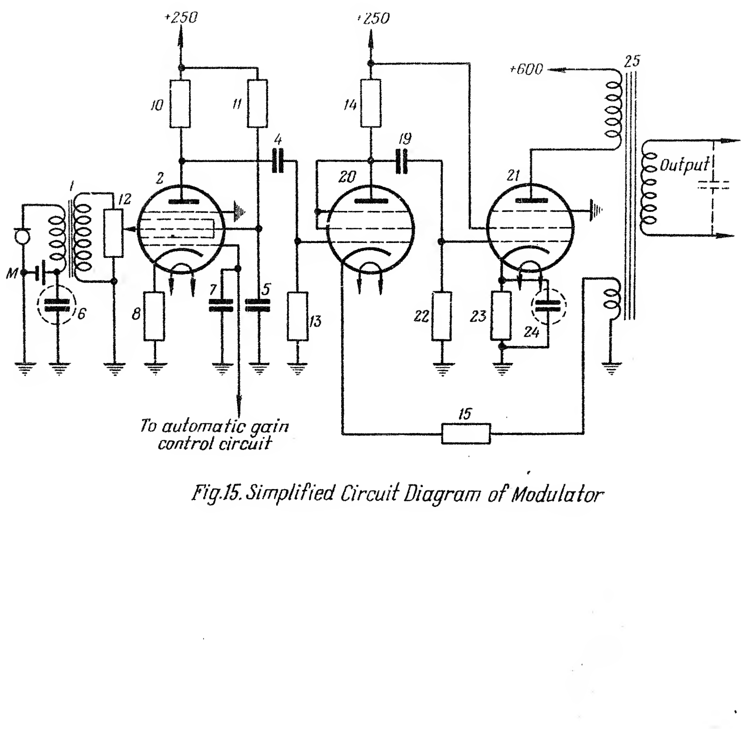

Fig.15. Simplified Circuit Diagram of Modulator

The modulator is a three-stage audio frequency amplifier.

Audio frequency voltage from the microphone, or an external source, is applied to the primary winding of input (microphone) transformer 1. Via volume control 12 the audio frequency voltage is fed from the secondary winding of transformer 1 to the third grid of valve 2 of the first modulator stage.

The first stage of the modulator is a resistance-coupled audio frequency amplifier, employing a 6A7 valve. The anode load of first modulator stage valve 1 is resistor 10, from which the audio frequency voltage is applied via blocking capacitor 4 to the control grid of second modulator stage valve 20.

Multigrid valve 2, pentagrid, has been used due to the fact that the first modulator stage employs automatic gain control which is obtained by applying a negative voltage to the first grid of the valve.

The cathode circuit of the valve includes resistor 8 for obtaining self-bias developed by the anode current, for the control grid of the valve.

Voltage of +250 volts is applied to the anode of the valve via resistor 10 and to the screen grid via dropping resistor 11.

The second stage of the modulator is also a resistance-coupled audio frequency amplifier, employing a 6Ж8 valve. This valve operates as a triode because its screen grid and suppressor grid are connected to the anode.

The anode load of the second modulator stage valve is resistor 14 from which audio frequency voltage is fed via blocking capacitor 19 to the control grid of third modulator output stage valve 21. A voltage of +250 volts is applied to the anode of the valve via resistor 14.

The third stage is the output stage of the modulator, which employs transmitting pentode 21, type ГУ-50. The anode load of the third stage valve is output modulation transformer 25, from the secondary winding of which audio frequency voltage is applied to the suppressor grids of the ГУ-80 valves of the fifth transmitter stage.

The cathode circuit of the ГУ-50 valve includes resistor 23 which is by-passed by high-capacity condenser 24 (electrolytic). Across this resistor the D.C. componenet of the anode current develops self-bias for the control grid of the valve.

A voltage of +600 volts is applied to the anode of the ГУ-50 valve via the primary winding of transformer 25. The screen grid is supplied with +250 volts.

The second and third modulator stages use negative feedback.

The cathode of second stage valve 20 is connected to earth via resistor 15 and the additional winding of output transformer 25. As a result part of the output audio frequency voltage from the additional winding is applied via resistors 13 and 15 to the control grid of the second stage valve. The direction of the turns of the additional winding is selected so that the audio frequency voltage supplied by the winding is in anti-phase (180^0 out of phase) with the input voltage of the second stage valve.

Automatic Gain Control (AGC)

Examination of the modulation curve shown in Fig.14 brings us to the conclusion that distortionless modulation can be obtained only within the limits of the suppressor grid voltage variation on the output valves lying between $E_{g3\ min.}$ and $E_{g3\ max.}$

Further increase in the amplitude of the supressor grid voltage disturbs the linearity of the relationship between the audio frequency voltage U_{Ω} and the amplitude of the radio frequency current in the antenna. With very great amplitudes of the audio frequency voltage U_{Ω} , the output valves of the transmitter are

cut off, i.e. intervals of time appear when the radio frequency voltage is zero. This causes over-modulation.

Over-modulation is an undesirable phenomemon, because it produces distortion which decreases the intelligibility of telephone transmissions and broadens the band of side frequencies radiated by the antenna.

For this reason it becomes necessary to reduce the gain of the modulator so that even the loudest sounds spoken into the microphone would not produce over-modulation. If this demand is satisfied, then 100 per cent modulation will occur only at transmission peaks; the average modulation depth, on the other hand, will be of the order of 30 per cent. A low average depth of modulation is unprofitable because then the transmitter power is not fully used in the telephone transmission, and the communication range of the station is reduced.

The modulation circuit of the transmitter has provision for increasing the average depth of modulation, without running into over-modulation on peaks. This is obtained by incorporating automatic gain control in the modulator, with the aid of which the overall gain is decreased beginning with a definite value of input voltage, corresponding to a modulation depth of 60 - 70 per cent.

The closer approaches the output voltage the value required for 100 per cent modulation of the transmitter, the lower must be the gain of the modulator.

The automatic gain control circuit diagram is shown in Fig.16.

The operating principle of the automatic gain control consists in alternating voltage from output transformer 25 being applied to rectifier valve 56 via capacitor 27 and potentiometer 33.

Audio frequency voltage from potentiometer 33 is rectified by diode 56, and a voltage is developed across resistor 60, the minus of which is fed via the audio frequency filter formed by resistors 16 and 59 and by capacitors 7 and 18 to the first grid of first modulator stage valve 2. The higher the audio frequency voltage at the output of the modulator, the greater the rectified voltage across resistor 60, and the lower the gain of the first modulator stage.

In order to retain a high gain factor at low output voltages (when modulation depth is low), rectified voltage across resistor 60 appears only when the output voltage reaches a definite value. This is achieved by introducing a delay voltage into the diode circuit, which is adjusted by potentiometer 58.

With the use of the automatic gain control, the amplitude characteristics of the modulator (the dependence between the input and the output voltages) takes the shape shown in Fig.17.

The use of automatic gain control allows the average modulation depth to be increased to 50 - 60 per cent.

Modulation Depth Indicator

In practice, modulation depth is measured either by special instruments called modulation meters or by cathode ray oscillographs. These instruments have a sufficiently complex design, which makes inexpedient to build them into a transmitter.

At a constant amplitude of radio frequency voltage on the control grids of the output stage valves, the modulation depth is determined, in the main, by the value of the modulating audio frequency voltage obtained at the output of the modulator. For this reason modulation depth is monitored in the transmitter with the aid of a valve voltmeter which measures the audio frequency voltage at the modulator output.

The galvanometer of the valve voltmeter is calibrated directly in modulation percentage and provides sufficient reading accuracy.

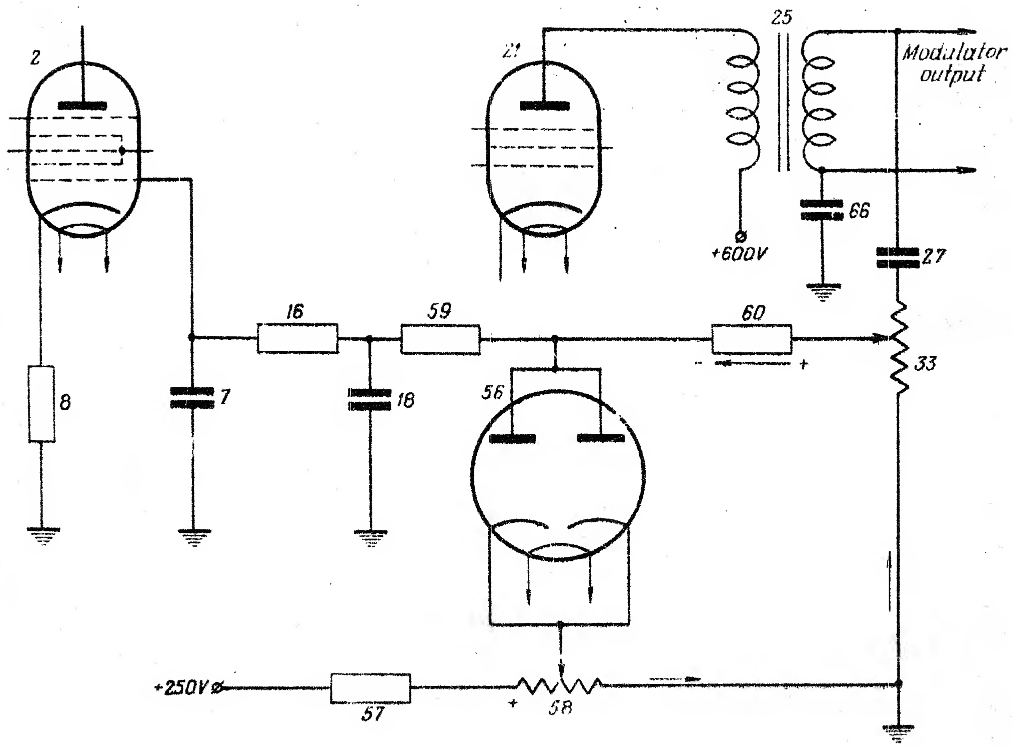

Fig. 16. Automatic Gain Control Circuit

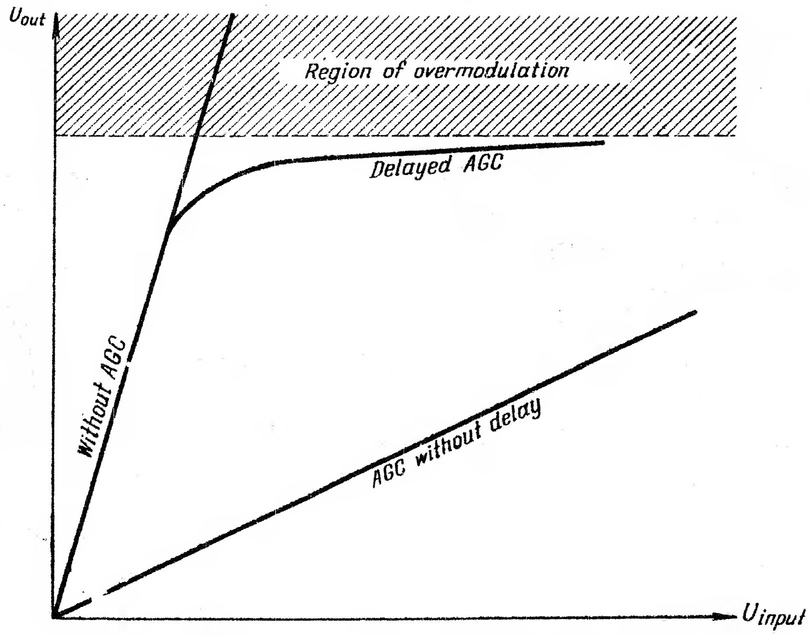

Fig. 17. Amplitude Characteristics of Modulator

The circuit diagram of the valve voltmeter which serves as the modulation depth indicator is shown in Fig. 18.

For the sake of simplicity the two diodes of valve 35 are shown separately. The circuit is that of a full wave rectifier. Each diode passes current during one half wave of the audio frequency voltage.

The current of each diode branches out, a part of it flowing through resistors 32 or 31 and part through galvanometer 34. The higher the audio frequency voltage at the output of the modulator, the higher the depth of modulation, and the higher the reading of meter 34. The passage of current through the diodes is shown by arrows in Fig. 18.

Tone Generator and Monitoring Stage

In order to obtain tone-modulated telegraph operation,the modulator assembly of the transmitter includes a tone generator producing a frequency of about 1000 c.p.s.

The tone generator (Fig. 19) employs valve 36, type 6Ж8, in the circuit of a self-excited valve oscillator. The tuned circuit consists of the inductance

of one of the windings of transformer 37 and capacitors 43 and 55. The other winding of transformer 37 is the feedback winding which supplies audio frequency voltage to the control grid of valve 36 via capacitor 47.

A voltage of +250 volts is applied to the anode of valve 36 via the winding of transformer 37 of the anode oscillatory circuit. A tension of +250 volts is applied to the screen grid of valve 36 via dropping resistor 39. During operation of the tone generator, bias is applied to the control grid from cathode resistor 40.

In telegraph operation, keying occurs simultaneously in the master oscillator of the transmitter and the tone generator circuit. Relay 64, the contacts of which are shown in Fig. 19, is actuated by the telegraph key. When the key is depressed, the break-make contact of keying relay 64 short circuits resistor 61 and connects the control grid of tone generator valve 36 to earth via resistor 38; in this case the bias of the control grid of valve 36 is determined solely by the voltage across resistor 40, and the tone generator operates normally. When the key is released, the break-make contact of keying relay 64 is drawn to the right, as a result of which a potentiometer is formed by resistors 50 and 61,

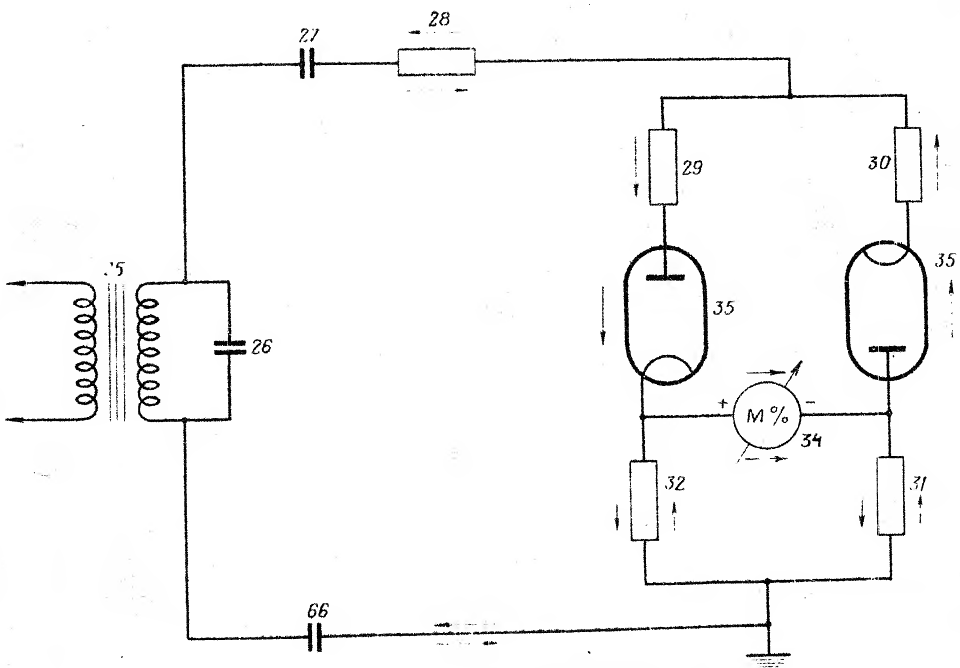

Fig. 18 Circuit Diagram of Modulation Depth Indicator

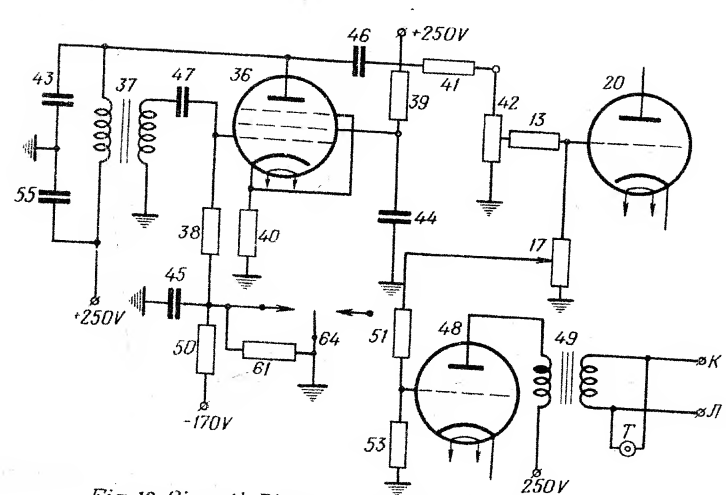

Fig. 19. Circuit Diagram of Tone Generator

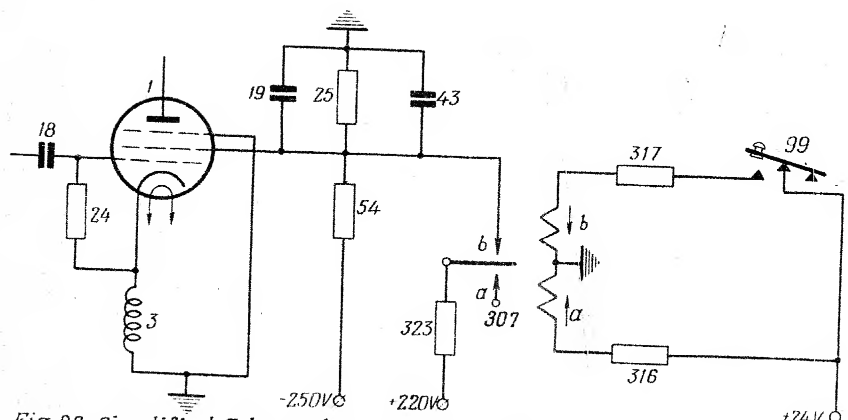

Fig. 20. Simplified Telegraph Keying Circuit for Continuous Range

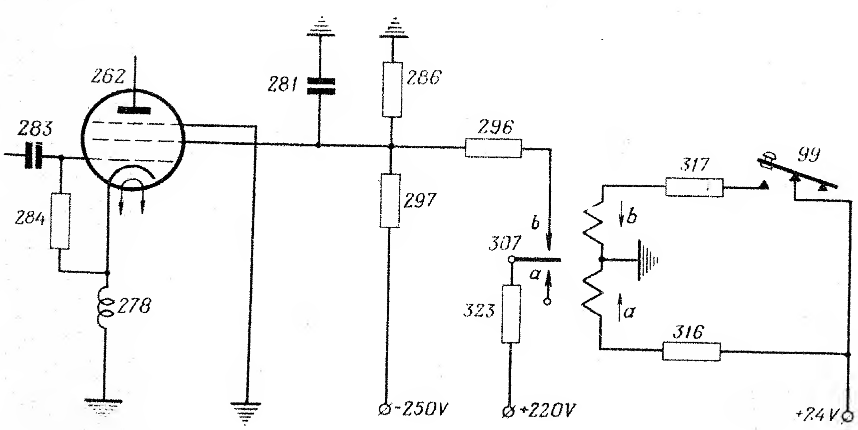

Fig. 21. Simplified Telegraph Keying Circuit for Crystal-Controlled Operation

to which -170 volts are applied. A part of this voltage is fed from resistor 61 via resistor 38 to the grid of valve 36, this cuts off the valve and the tone generator no longer operates.

The audio frequency of the tone generator is applied via blocking capacitor 46, resistor 41, potentiometer 42, and resistor 13 to the control grid of second modulator stage valve 20 and potentiometer 17.

Potentiometer 42 provides adjustment of the modulation depth of tone modulated oscillations.

The tone generator voltage is also used for supplying the headphones of remote posts and receivers with signals for aural monitoring of the transmitter operation. As the telephones are connected to the line КЛ, which carries service calls, then in order to protect the modulator against audio frequency voltage from the line КЛ and to prevent inadvertent transmission of service calls by radio, the monitoring signals are fed to the line via a separate valve stage.

Audio frequency voltage of the tone generator is applied from potentiometer 17 to the grid of valve 48, type 6Ж8, of the monitoring stage via resistor 51. The stage employs a transformer coupled audio frequency amplifier circuit. The secondary winding of this transformer (49) is connected to the line КЛ.

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This circuit provides monitoring of the telegraph and telephone operation of the transmitter. The volume of the monitoring signals can be adjusted with the aid of potentiometer 17.

10. Telegraph Keying

Telegraph keying of the transmitter is achieved directly in the excitation stages.

The advantage of this system over circuits where intermediate stages of the transmitter are keyed is that with keying of the master oscillator the releasing of the key interrupts oscillation completely, removing variable radio frequency voltage from the grids of the valves of all stages. In this case, when the key is released, there is no radiation from the antenna (no so-called residual or negative radiation), no interference at all with reception, the probability of the enemy discovering the station during prolonged pauses is excluded, and it is possible to hear the station being contacted during brief pauses in transmission.

Depending on the mode of operation, the keying circuit is connected to either the continuous range master oscillator or the crystal-controlled oscillator.

A simplified circuit diagram of telegraph keying in continuous range operation is shown in Fig. 20.

When telegraph key 99 is released, current flows from the +24-volt source via resistor 316 through half the winding of keying relay 307 in the direction shown by arrow a. The relay armature is attracted to the vacant contact a, and the screen grid of master oscillator valve 1 is supplied with a negative tension of -20 volts from the potentiometer formed by resistors 25 and 54 to which -250 volts are applied. With the armature in this position, the master oscillator valve is cut off. The master oscillator generates no radio frequency oscillations.

With key 99 depressed, current from the +24-volt source flows through resistor 317 and the other half of the winding of keying relay 307 in the direction shown by the arrow b. Due to the difference in the values of resistors 316 and 317, the current flowing through resistor 317 is considerably higher then that flowing through resistor 316, as a result of which the upper half of the winding exerts greater attraction, pulling the armature of relay 307 to contact b.

The current flowing through resistor 54 is approximately doubled, as the positive source (+220 volts) and the negative source (-250 volts) are connected in series with respect to the circuit consisting of resistors 54 and 323. A re-distribution of voltages occurs in the sections of the circuit, and the screen grid of valve 1 is fed with a positive voltage with respect to earth, which opens the valve. With the telegraph key in this position, the master oscillator generates radio frequency oscillations.

It should be noted that the time required for the screen grid voltage of valve 1 to change depends only on the time constant of the circuits and not on the time of travel of the armature of keying relay 307.

With a view to narrowing the band of radiated frequencies in telegraph operation, the time constant of the screen grid circuit is selected so as to obtain a telegraph signal of a smoothened shape.

Capacitors 19 and 43 bypass the screen grid for radio frequencies and simultaneously determine, in conjunction with the resistors of the screen grid circuit, the value of the time constant.

A simplified circuit diagram of telegraph keying for operation on crystal-controlled frequencies is shown in Fig. 21.

When the crystal oscillator is operating, amplitude keying is achieved with the aid of a circuit similar to the keying circuit ised in the continuous range. A slight difference lies in the fact that +220 volts are applied to the screen grid of valve 262 of the crystal-controlled oscillator via resistor 296.

In parallel with relay 307 is connected keying relay 64 (See Fig. 19) of the tone generator. In CW operation relay 64, by operating simultaneously with relay 307, makes it possible to monitor the telegraph operation of the transmitter aurally. On tone-modulated operation, relay 64, in addition to monitoring the operation of the transmitter, sends tone signals to the modulation assembly of the transmitter.

When the crystal-controlled oscillator is operated from printing telegraph sets, the latter are connected via a keying line to the input of an electronic relay which actuates frequency keying relay 298.

11. The BC-1 Rectifier Assembly

The transmitting radio station is supplied by a special rectifier assembly (See Appendix 14).

The rectifier assembly includes six selenium rectifiers and three separate transformers, which supply all the necessary voltages to all the circuits of the radio station.

The basic data of the assembly are given in Table 5.

The rectifier assembly is supplied from three-phase A.C. mains of 220/380 volts. The A.C. heater voltages are obtained with the aid of four step-down transformers.

The A.C. voltage of 220 volts indicated in Table 5 is obtained from one of the phases of the primary winding of three-phase transformer 561 of the B-1 rectifier.

The D.C. voltages indicated in Table 5 are obtained from selenium rectifiers.

Features of Selenium Rectifiers

The selenium rectifiers used in the radio station feature high basic characteristics:

(a) operation in both high (up to +50°C) and low (-25°C) ambient air temperature conditions;

(b) constant readiness for operation;

(c) simplicity of operation;

(d) the ability to withstand short-time overloads and overvoltages;

(e) low sensitivity to blows and vibrations;

The voltage drop across the internal resistance of the selenium element, when current is flowing in the forward direction, is known as the forward voltage drop. It is chiefly this voltage drop and the current flowing through the element which determine the loss in the element and, consequently, the associated heating of the element. Therefore, if overheating, which can cause damage, is excluded, a selenium rectifier element can produce only a definite value of rectified current, which depends on the working surface of the element, the circuit, and the ambient temperature.

Artificial cooling of selenium elements makes it possible to increase the load current of the elements. In order to obtain high rectified voltages, selenium elements are connected in series (in stacks) so that the inverse voltage per element would not exceed the permissible value, while in order to obtain high currents, elements (stacks) are connected in parallel. In addition, selenium elements are connected in special rectifier circuits which allow both half-waves of single-phase and three-phase alternating current to be used.

The maximum permissible heating temperature of selenium elements is $+75^{\circ}C$. When operating at a high ambient temperature ($+50^{\circ}C$), the permissible load of selenium stacks reduces considerably. Heating of stacks in excess of $+75^{\circ}$ can damage them.

The operation of selenium stacks is considerably affected by moist air especially during prolonged inoperation of the rectifier. With moist elements the resistance of the working surface decreases, causing partial breakdown of discs when the working voltage is switched on. In this case the selenium layer fuses at the points of breakdown and no longer conducts current. Several places of breakdown decrease the working surface of the elements.

If stacks are kept de-energized for a long time, so called "unforming" of the selenium elements is observed which consists in a decrease of the stack resistance to inverse current. This causes an inverse current rise during the first few minutes after switching on and results in heating the selenium elements even without a load. In two-three minutes the rectifying properties of the stacks are restored and subsequent operation proceeds normally.

After prolonged operation of selenium elements an increase in their forward resistance is observed, which reduces the rectifier output voltage. This process is called "aging". In order to compensate for this decrease in rectified voltage it becomes necessary to increase the alternating voltage applied to the selenium elements. For this reason the selenium rectifiers are provided with a means of switching the transformer windings, making it possible to increase the A.C. voltage applied to the stacks by 6 - 7 per cent.

Aging is an irreversible process, i.e. the resistance does not decrease neither after prolonged interruptions in operation nor with improved ventilation. Gradually increasing, the voltage drop across the selenium elements reaches a value when even working current produces such a power loss that the associated heating of the selenium elements rapidly destroys them. Usually, the service life of a selenium stack is defined as the time required for aging to reach such a value that the rectified voltage decreases by 10 per cent. For ordinary elements operating under normal load and operating conditions, this period equals 10,000 hours. When selenium elements are heated to +80°C, the aging

process is accelerated and the life of the selenium elements decreases to several hundred hours; with heating to +90^{0} their life decreases to several hours.

In case of failure of elements of the selenium stacks, the whole stack must be replaced, as dismantling of the stack is impermissible due to violation of the protective coating.

Selenium Rectifier Circuits

The low-power rectifiers of the BC-1 assembly employ a single-phase bridge circuit, while the powerful rectifiers employ a three-phase bridge circuit.

In the single-phase bridge circuit (Fig. 23) alternating current from transformer 5 passes during one half-wave through those two legs of the four, the forward direction of which coincides at the given moment with the direction of the current.

For example, having passed through leg 1 (Fig. 23 b) current flows through load 6 and returns to transformer 5 via leg 3 which is connected in the same direction.

During the second half-wave (Fig. 23 c) current passes through leg 4, then again through load 6 and returns to transformer 5 via leg 2.

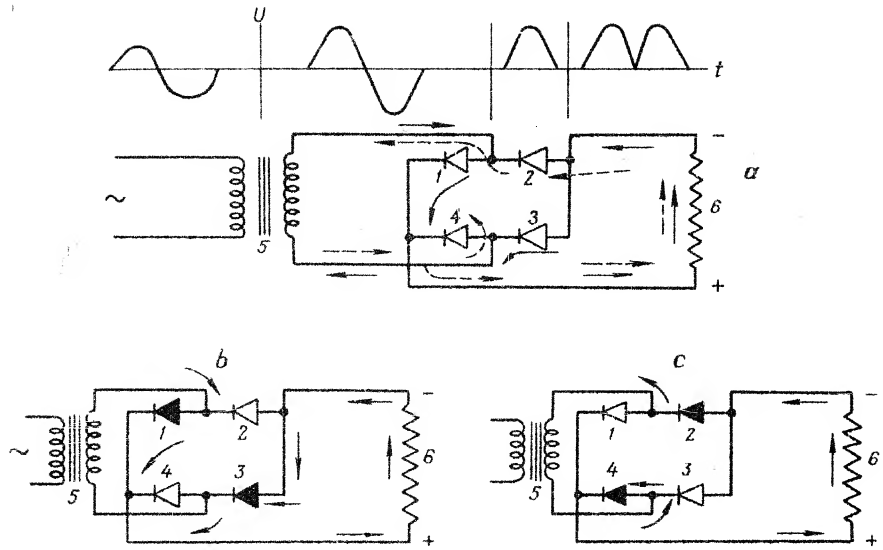

Fig. 23. Single-Phase Bridge Circuit

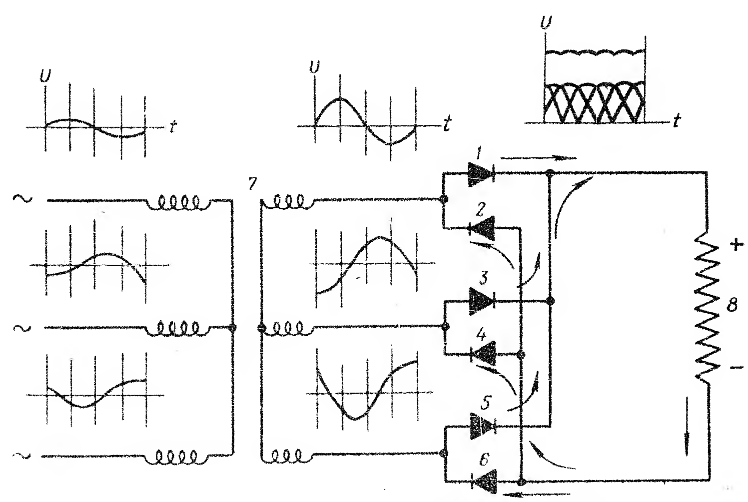

Fig. 24. Circuit of Three-Phase Bridge Rectifier

The direction of the current in the load remains the same despite the change in direction of the transformer current (Fig. 23 a).

In the three-phase bridge circuit (Fig. 24), when the direction of the current of one of the phase windings of transformer 7 corresponds to one of the legs connected to it (for example, 1 in Fig. 24) current passes through this leg and then through load 8 back to the transformer at first through leg 6 to the third phase, and then, when the voltage of this phase increases, through leg 4 to the second phase. During the second third of the cycle when the voltage across the second phase of transformer 7 exceeds the voltage of the first phase, current passes through leg 3, load 8, and from there through legs 6 and 2 to the third and first phase windings of the transformer. In the same way it is possible to follow the passage of current during the last third of the cycle when first leg 5 operates and and then legs 2 and 4 do.

As seen from the drawing, the direction of the current in load 8 remains constant in all cases.

Each leg of the bridge passes current during only one third of a cycle and not during half a cycle as in the case of the single-phase circuit. For this reason

the nominal load of selenium elements in a three-phase circuit can be increased considerably, and powerful selenium rectifiers usually employ a three-phase bridge circuit despite the fact that it is somewhat more complex.

A three-phase bridge circuit allows rectified voltages of half the nominal value to be obtained, without any variations in the voltage across the winding of the rectifier transformer. This is achieved by connecting the load between one of the output terminals of the bridge circuit and the zero point of the secondary windings of the star-connected transformer (Fig. 25).

In this case the circuit operates in the following way. At a certain moment, current, which has begun flowing through leg 1, for example, passes through load 8 and returns to transformer 7 to the same phase via the zero wire. The leg 3 begins to operate, and the current having also passed through load 8, returns to the zero point of the transformer. At the next moment leg 5 will operate. As seen from the circuit diagram, legs 2, 4, and 6 do not operate at all. As the number of rectified current pulses per cycle with the given circuit is half the number produced by the three-phase bridge circuit and, in addition, a lower (phase) voltage of transformer 7 is used, the rectified voltage at the output will be reduced two times.

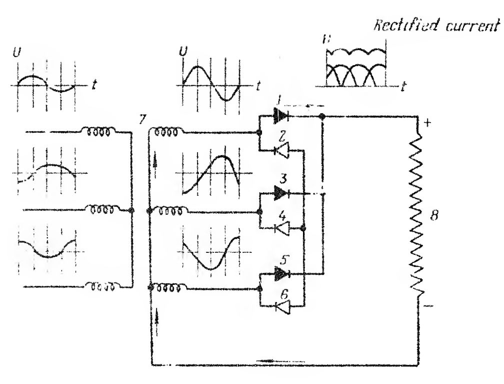

Fig. 25. Circuit of Three-Phase Rectifier with Zero Lead

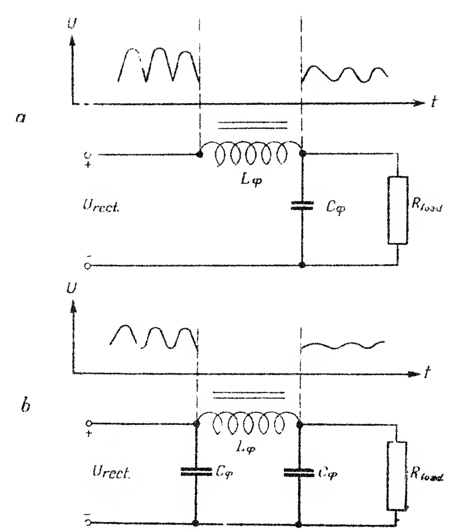

Fig. 26. Filter Circuits
a – choke input filter; b – capacitor input filter

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Rectifier Filters

The rectified voltage at the output of the rectifier is of the pulsating type. The magnitude and frequency of the pulsations (ripple) depends on the rectifier circuit and the frequency of the supply mains.

Filters are used in order to smoothen the ripple of the rectified voltage.

The purpose of a filter consists in separating the D.C. and A.C. components of the rectified voltage so that the A.C. component across the load would be attenuated as much as possible. This is achieved by using filters consisting of chokes L_f (Fig. 26) with iron cores and capacitors C_f having a high capacity. Chokes present a high resistance for the A.C. component of rectified current, passing its D.C. component with hardly any attenuation.

A capacitor, which passes the A.C. component of the rectified current, passes practically none of the D.C. componennt In addition, the charge of the condenser helps to maintain a constant voltage across the load. Some of the BC-1 rectifiers use capacitors and chokes connected in condenser-input filters, some connected in choke-input filters. Fig. 26 shows these two circuits and the approximate distribution of the components of the

rectified voltage. For various circuits the ratio of the A.C. component to the D.C. component of the rectified voltage varies from 67 per cent for a single-phase bridge circuit to 6 per cent for a three-phase bridge circuit.

The parameters and circuit of the filter are chosen to ensure the required smoothing of the pulsating voltage. Thus, for example, rectifiers B-2, B-3 and B-4 use condenser-input filters, which smoothen the ripple to 0.05 per cent while rectifiers B-5 and B-6 use filters of the choke-input type, which smoothen the ripple to 0.15 per cent.

Voltage Stabilizers

To a great degree the stability of the master oscillator frequency depends on the constancy of the voltages supplying it and in particular on the constancy of its anode voltage.

For this reason the output of the B-3 rectifier supplying the anode circuit of the master oscillator is provided with an electronic voltage stabilizer. Its purpose is, in the first place, to maintain the voltage constant within ±2 per cent during variations of the mains voltage of ±10 per cent and, in the second place, to reduce the ripple voltage considerably.

The stabilizer (Fig. 26) employs three valves: Л4 (type 6В4), Л11 (type 6Ж8) and Л12 (type СГ-2С), a number of resistors and capacitors, connected in a common circuit.

We shall examine in detail the operation of the electronic stabilizer circuit shown in Fig. 27.

The anode voltage of the valve Л4 is equal to the voltage difference of U_1 and U_{st}, i.e. $U_{Л4} = U_1 - U_{st}$. The bias voltage at the grid of the valve Л4 is equal to the algebraic sum of the voltages $U_{st} + U_{Л11} + U_{Л12}$ with U_{st}, the negative side of which directed towards the grid, and $U_{Л11} + U_{Л12}$ having the opposite polarity. The resulting bias voltage at the grid of the valve Л4 is normally negative. The neon gas-discharge valve Л12 (called a stabilivolt) is supplied with the voltage U_1 via the series resistors R_{27}. A constant voltage of 75 volts is set up across it regardless of small variations in U_1. The anode of the valve Л11 is also supplied with the voltage U_1 via the anode resistor R_{24}. The cathode circuit of this valve includes the stabilivolt Л12. Screen grid voltage is supplied to the valve Л11 from the potentiometer consisting of the resistors R_3 and R_{25}. The control grid of the valve Л11 is supplied with the sum of the voltages U_3 and $U_{Л12}$,

which are of opposite polarity. A predominance of the voltage $U_{Л12}$ over the voltage U_3 develops negative bias at the grid of the valve $Л_{11}$. When the input voltage U_1 is normal, the grid of the valve $Л_{11}$ is supplied with the low negative bias required for the valve to operate as a class-A amplifier. It should be borne in mind that any change in the control grid voltage of the valve $Л_{11}$ can only be due to a change in the voltage U_3, as the voltage $U_{Л12}$ remains practically constant. The main function of the stabilivolt $Л_{12}$ is the stabilization of the voltage $U_{Л12}$.

Stabilization of the voltage U_{st} occurs exclusively due to variations in the anode voltage $U_{Л4}$ of the valve $Л_4$, as seen from the equation:

$$U_{st} = U_1 - U_{Л4}.$$

When the voltage U_1 varies within certain limits the voltage $U_{Л4}$ must also vary within the same limits for the value of U_{st} to remain constant. This is achieved automatically by a corresponding change in the grid voltage of the valve $Л_4$ when U_1 changes. When the non-stabilized input voltage U_1 increases, then, due to the time constant of the circuit, the voltage U_{st} also increases for a fraction of a second, causing a rise in U_3. This decreases the bias voltage at the grid of the valve $Л_{11}$, increasing its anode current. As a result $U_{Л11}$ decreases due to an increase in the voltage drop

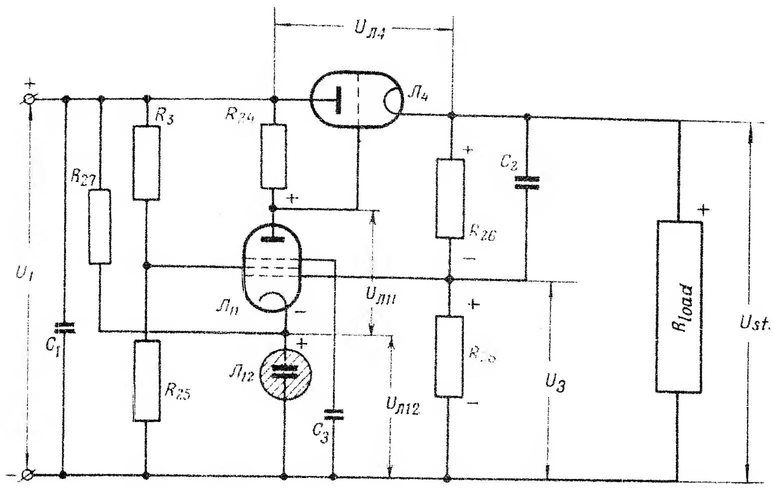

Fig.27. Circuit of Electronic Stabilizer

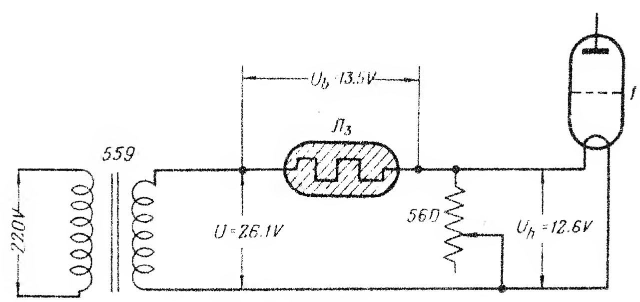

Fig.28. Circuit of Heater Stabilization of Master Oscillator

across R_{24}, and simultaneously the summated voltage UЛ11 + UЛ12 also increases. The grid voltage of Л4, which is equal to the anode voltage of the valve Л11 also decreases (i.e. the negative bias rises) and the internal resistance of the valve Л4 to direct current increases, causing an increase in UЛ4 . As a result, the increase in the voltage U_{st} will be compensated by an increase in the anode voltage of the valve Л4, and the voltage U_{st} will regain its former value. The whole process occurs very rapidly, and therefore the output voltage U_{st} remains practically constant.

When the non-stabilized input voltage U_1 decreases, the stabilization process occurs in the opposite order, i.e. the voltage UЛ4 decreases, and the voltage U_{st} increases to the initial value.

In addition to stabilizing voltage, an electronic stabilizer smoothens the ripple of the rectified voltage. The smoothing process is the same as the stabilizing process. In this case the A.C. component of the ripple voltage is applied to the grid of the valve Л11 via the capacitor C_2. Capacitors C_1 and C_3 function as bypass capacitors for ripple currents.

Transformer 559 (Fig. 28) is provided with a separate secondary winding for supplying the heater circuit

of the master oscillator valve. The stabilizer used in the circuit is the barretter Л3, type 1Б10-17. The barretter is a glass envelope filled with hydrogen which houses a thin iron wire.

The stabilizing action of a barretter is based on the fact that the resistance of the iron wire increases with heating. If the voltage of the circuit has increased, the current of the circuit is kept from increasing by an increase in the resistance of the iron filament of the barretter. Thus the current in a barretter circuit remains constant within certain limits.

The barretter is connected in series with the heater of valve 1. Stabilization of the heater voltage across it is due to the variation in the voltage drop across the barretter. For the given type of barretter, the variation in U_b should be within 10 - 17 volts, after which stabilization is disturbed.

A barretter reacts slowly to variations in the circuit voltage due to comparatively slow heating of its filaments. As a result, instantaneous variations in voltage are not stabilized by it.

The heater current of the master oscillator valve, type ГУ-50, is 0.7 - 0.83 amperes, while the normal current of the barretter is 1 ampere. For this reason the

ballast resistor 560 is connected in parallel with the heater of the ГУ-50 valve, increasing the barretter current to the normal value. All the other БС-1 rectifiers are not provided with stabilizing devices.

Protection Devices

The circuits of the rectifiers В-1, В-2, В-3, and В-4, the heater transformers, and the mains leads are provided with fuses (See Appendix 14) for protection against overloads. In parallel with fuses 541 in the heater circuits and the transformer circuits of rectifiers В-2, В-3, and В-4, are connected the series-connected resistors R_2 and the signal neon lamps $Л_2$. In case of overload the fuse burns out and the voltage of the circuit is applied to the neon lamp. The neon lamp glows, indicating which fuse has blown.

The powerful rectifiers В-5 and В-6 are not provided with fuses; they are protected by overload relays 511 and 537 included in the minus leads of the rectifiers. The overload relays are adjusted to operate at 1.5 times the load current, breaking the primary circuits of the supply transformer.

In order to avoid damaging the transmitting valves, anode and screen voltage is applied to them only after

the heaters of the valves have warmed up. In order to preclude application of high voltage before heating up of the valve cathodes, the BC-1 rectifiers are provided with a time relay. The relay affects the rectifiers B-3 and B-4 directly. The switching on of the rest of the rectifiers depends on the switching on of rectifier B-4. Consequently, the time relay affects the switching on of all the rectifiers with the exception of rectifier B-1. The time relay (Fig. 29) consists of the electronic valve Л$_{10}$, with electromagnetic relay 536 in its cathode circuit. The winding of this relay is energized by the anode current of the valve Л$_{10}$. But relay 536 does not operate until the anode current reaches a definite value. Heater voltage is supplied to the time relay valve Л$_{10}$ from the heater transformer of power stage 538 via the dropping resistor R_7. An anode voltage of +24 volts is supplied by the rectifier B-1 via the interlock contacts БК of the transmitter and the switch B. An anode voltage of +24 volts is used because at the moment of switching on of the relay this is the only available voltage as all the others appear only after operation of relay 536.

Heater voltage for the valve Л$_{10}$ is supplied simultaneously with the heater voltages of the transmitter

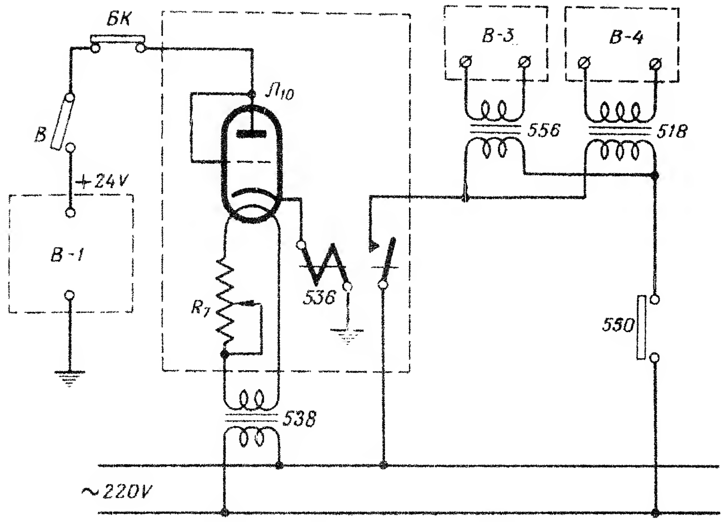

Fig. 29. Connection Diagram of Time Relay

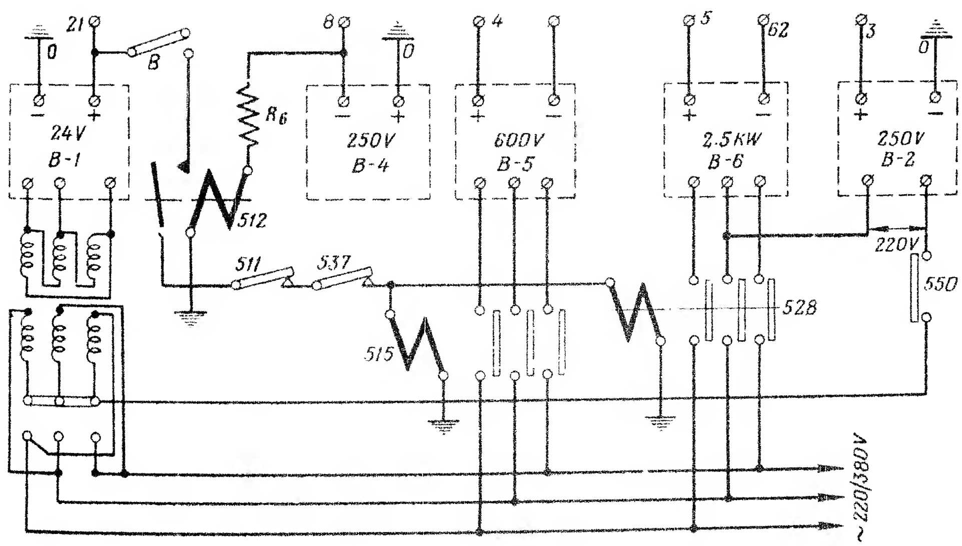

Fig. 30. Connection Diagram of Grid Bias Relay

valves, and relay 536 will not operate, even with the anode voltage on, until the indirectly heated cathode of the valve Л10 heats up to the normal temperature and the required anode current begins to flow. With the aid of the variable resistor R_7, the heating time of the cathode can be adjusted within 20 - 50 seconds.

The rest of the rectifiers can be switched on only after switching on of the rectifier B-4 and the appearance of the -250-volt bias voltage. By this time the cathodes of the transmitter valves have reached their normal temperature and application of the high voltage to the valves is safe.

The powerful transmitting valves, which are supplied with bias voltage from a separate source, can fail due to excessive anode current caused by the absence of bias voltage. In order to avoid this, the load resistance at the output of the B-4 rectifier has grid-bias relay 512 with series resistor 512 (Fig. 30) connected across it. This is an ordinary electromagnetic relay with normally open contacts. When the rectifier B-4 is switched on, relay 512 operates and supplies +24 volts to the supply circuit of contactors 515 and 528 via the closed contacts of overload relay 511 and 537 and the switch B. Contactors 515 and 528 operate, applying A.C. voltage to the rectifiers B-5, B-6, and B-2.

Signalling, Interlocking, Control and Monitoring Systems

Control operations of the rectifier, as well as certain types of faults, are monitored by light signals. Thus, for example, when mains voltage is applied to the rectifier, the neon lamps $Л_1$ (See Appendix 14) light up, signalling the presence of phase voltages, when heater voltage is switched on the green lamps of the control unit, the radio operator's post and the remote communication post light up, when high voltage is switched on the red lamps of the control unit, the radio operator's post, and the remote communication post light up.

When rectifier units and transmitter units are removed from their cases they do not require any high voltage protection devices, as in this case they are completely de-energised. High voltage is removed from the components mounted on the chassis due to the fact that their circuits are connected via the knife connectors of the unit which are disconnected when the units are removed.

The 5C-1 rectifier is switched on and off remotely from the control unit, or the remote posts (radio operator's post and remote communication post).

(a) a green lamp indicating that the station is ready for operation (heater voltage is being supplied);

(b) a red lamp indicating that high voltage is on;

(c) a white lamp indicating that the post is being called (for intercommunication).

When the radio station is switched on the whole control system is supplied by the 24-volt rectifier (B-1); when the radio station is switched off the calling and intercommunication circuits of the control system are supplied by the supply source of the switchboard. The electrical control system of the radio station may be divided into three parts:

(a) control of the power supply;

(b) control of service intercommunication;

(c) control of oscillations(keying and modulation).

The block diagram of the control system in shown in Fig. 31.

As seen from the diagram, the voltage of the ship's mains is fed via the ship's mains switch 501 to the 24-volt rectifier (B-1). From rectifier B-1, 24 volts are supplied to the remote communication post, radio operator's post and the control unit. When the push-button START (ПУСК) is pressed at the control unit, the radio operator's post or the remote communication post, the circuit which switches on high voltage is brought to a condition of readiness.

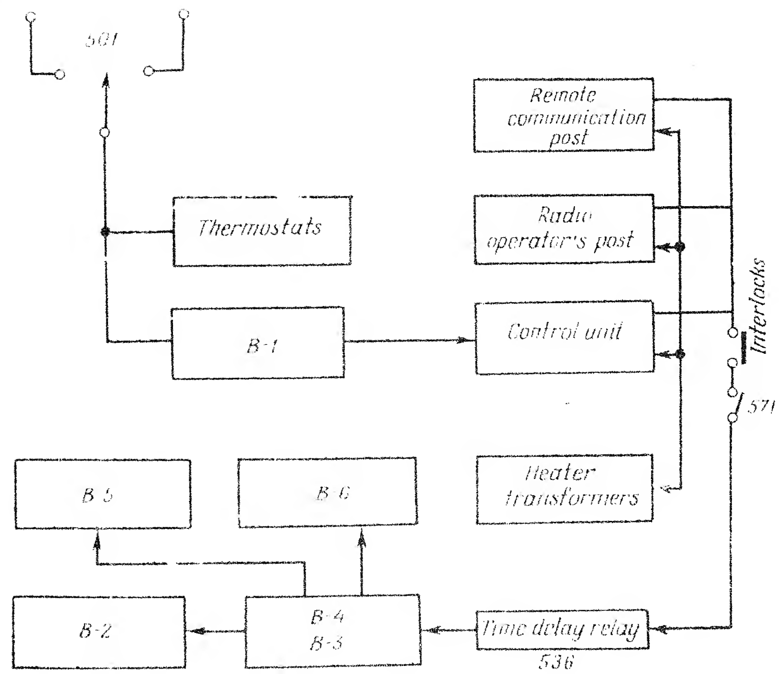

Fig.31. Block Diagram of Control System of the Radio Station

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When the toggle switch RADIO-INTERCOMMUNICATION (РАДИО-ВНУТР. ПЕРЕГОВОРЫ) of the control unit, remote communication post or radio operator's post is set in the position RADIO, 24 volts are applied to time relay 536 via the interlocking circuit and emergency switch 571. The time relay switches on the bias rectifier B-4 (-250 volts) and rectifier B-3 (220 volts) which supplies the master oscillator. Switching on of the rectifier B-4, which supplies the bias circuits, ensures that 24 volts are supplied to the contactors of the high-voltage rectifiers B-5 and B-6 (600 V and 2500 V); the contactors operate and supply voltage to the rectifiers, as a result of which high voltage is applied to the transmitter. Depression of the push-bottom STOP (СТОП) at the control unit, the remote communication post or the radio operator's post removes the 24 volts, bringing the system to the initial condition.

Telephone intercommunication between the control unit, the radio operator's post and the remote communication post is provided by the circuit shown in Fig. 32. The microphones M are supplied by the 24-volt current source from the switchboard via the microphone transformers TP, the switch П RADIO-INTERCOMMUNICATION (РАДИО-ВНУТР. ПЕРЕГОВОРЫ) and the contacts of the press-to-talk lever. Audio frequency is passed by the capacitor C.

The ear-pieces T are connected in parallel with the secondary windings of the microphone transformers TP. Thus the line КЛ serves as the telephone line for service intercommunication. If radio transmission have to be made, the switch П of the control unit, the radio operator's post or the remote communication post is set in the position RADIO (РАДИО). When this is done high voltage is applied to the transmitter and the microphone M is switched to the input winding of the microphone transformer of the transmitter's modulator.

The lamps Л serve for visual calling. When the call button КН is depressed, +24 volts are supplied from the switchboard to lamp Л via the line Л and the series resistor ДС and the lamp lights up.

Fig. 33 shows a simplified diagram of the telegraph keying circuit. In telegraph keying the oscillations can be controlled from the control unit of the transmitter or from any of the radio operator's posts or remote communication posts switched to the transmitter.

As seen from the diagram, the telegraph keys, the press-to-talk lever of the handsets, and push-button 322, which duplicates the operation of the key at the transmitter proper, are all connected in parallel. When a key press-to-talk lever or button 322 is depressed, +24 volts are supplied to the windings of relays 307, 64 and 118.

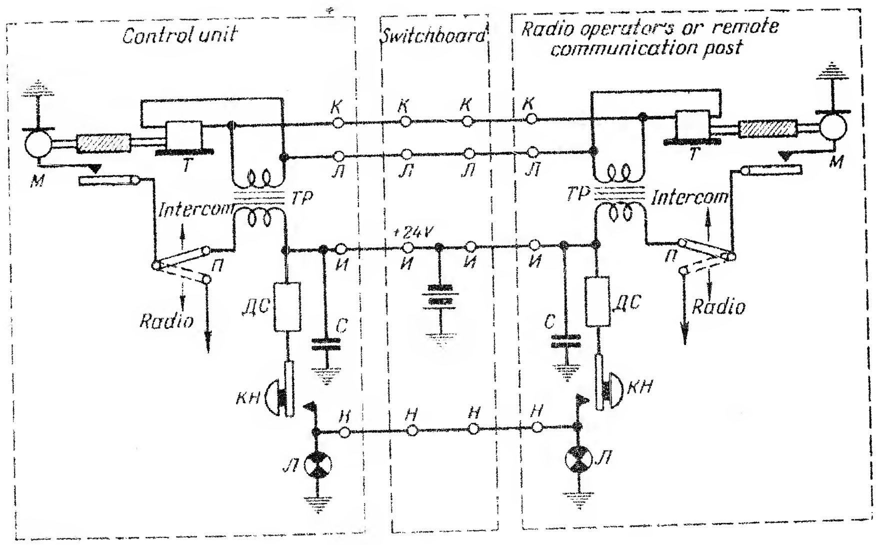

Fig.32. Intercommunication Circuit

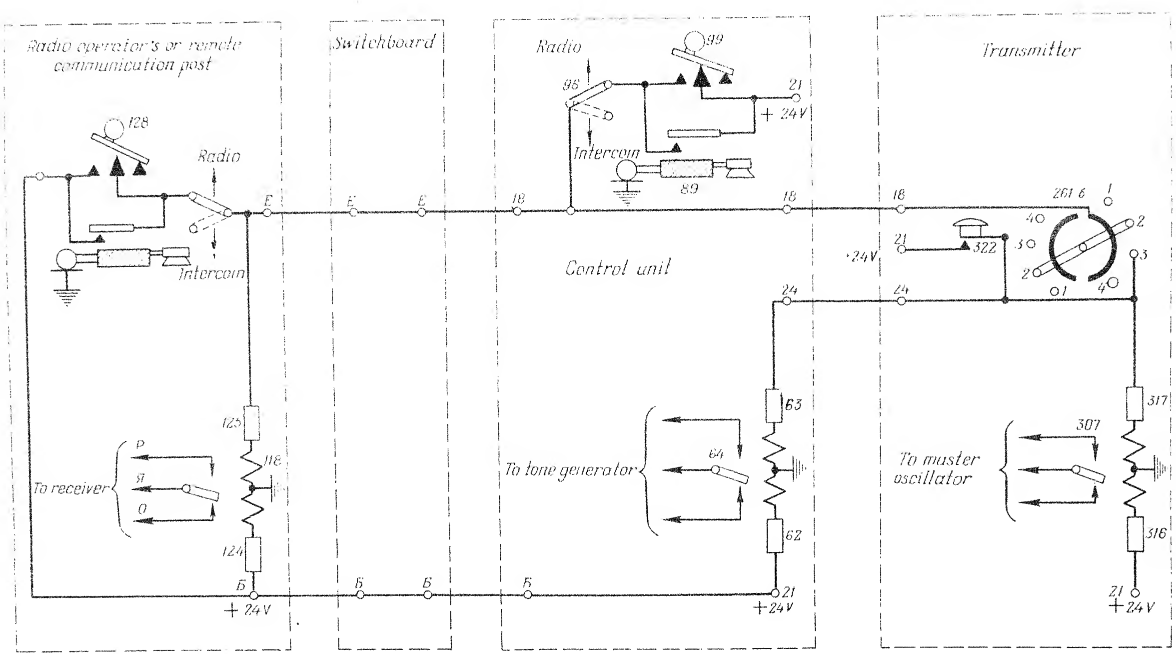

Fig. 33. Telegraph Keying Circuit

All three relays are connected in parallel and operate simultaneously. The functions of these relays have been described above, and Fig. 33 shows only the control of these relays.

13. Converters of the Radio Station

For operation form D.C. mains, the transmitting radio station is supplied with special converters, type П-7.2, or type ПТ-5.

The ПТ-5 Converter

A block diagram of the power unit of the radio station, employing a type ПТ-5 converter is shown in Fig. 34. Direct current from a mains of 110 or 220 volts is supplied via the supply switchboard ЩП and the starting device КРП-5 to the electric motor М and to the three-phase generator Г.

The electric motor of the unit is started and stopped from the supply switchboard with the aid of the push buttons START (ПУСК) and STOP (СТОП). Switching over from one supply mains to another is also controlled from here.

The switchboard includes a voltmeter and an ammeter which are constantly connected to the supply mains for

monitoring voltage and current, as well as protection provided by fuses and signal lamps which light up indicating which supply mains is connected.

The starting device KPH-5 switches a resistor into the circuit of the armature winding at the moment of starting of the electric motor, which is switched out in sections as the armature gains speed. It is impermissible to switch on the motor without the starting resistor as the armature winding has a low resistance and may burn out or be broken down by the high starting current. As the motor speeds up the starting resistors become unnecessary due to the development in the armature winding of the motor of a counter-electromotive force which reduces the armature current to the normal value. The starting resistor is switched on and out automatically with the aid of electromagnetic relays (contactors) located in the KPH-5 starting device.

The main stator poles of the electric motor carry two field winding: the series winding which is connected in series with the armature winding and the shunt winding which is connected in parallel with armature and the series winding. The magnetic fluxes of these windings add up, with that of the shunt winding predominating. This circumstance makes the electrical properties of the

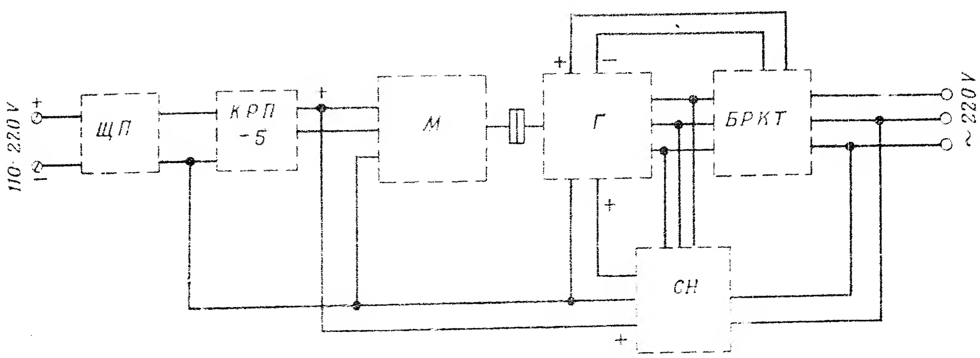

Fig. 34 Block Diagram of ПТ-5 Converter

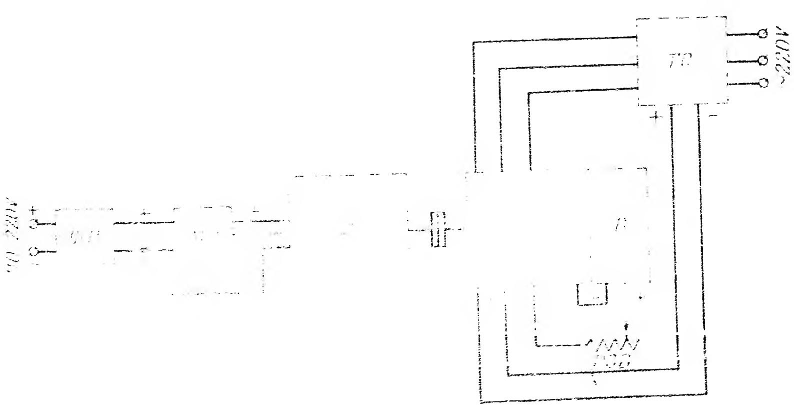

Fig. 35 Block Diagram of П-22 Converter

given motor close to those of a shunt motor which features constant speed with variations in the load. In the main, the series winding serves for increasing the initial torque when the motor is started. In addition to the main stator poles, the motor is provided with commutating poles with windings designed for eliminating reaction of the armature.

The generator of the converter has stator poles with two field windings: shunt and compound. The shunt winding is supplied by the D.C. mains and in parallel by voltage of the generator itself via one of the rectifiers of the voltage stabilizer CH. The magnetic flux developed by the mains current serves for excitation of the machine at the moment of starting, while the current supplied by the stabilizer subsequently develops the main magnetic field and maintains the generator voltage constant during variations of the mains voltage. The compound winding is supplied only with voltage from the generator via the second rectifier of the current-type stabilizer БРКТ. Its main function is stabilizing the generator voltage during changes of the load current with the aid of the current stabilizer included in the БРКТ unit. The magnetic fields of both windings are summated. The generator armature has one main winding which develops alternating three-phase

voltage of 220 volts. The voltage stabilizer СН maintains the generator voltage practically constant within 2-3 per cent with the voltage variations across the electric motor of from -20 per cent to + 50 per cent and with variations of the load current of the generator of from 0 to 100 per cent.

The П-7.2 Converter

A block diagram of the power unit of the radio station, employing a type П-7.2 converter is shown in Fig. 35.

Direct current from a mains of 110 or 220 volts is supplied via the supply switchboard ЩП and the starting device СПП to the electric motor М. The supply switchboard of the П-7.2 converter equipment is the same one used for the ПТ-5 converter.

The automatic starting device operates on the same principle as the КРП-5. The operating principle of the electric motor М of the П-7.2 converter is the same as that of the motor of the ПТ-5 converter. The armature of the generator Г has two windings: the main winding which develops a three-phase alternating voltage of 220 volts, and auxiliary winding which generates D.C. voltage which is supplied via field rheostat РЗВ to the shunt

stator winding for self-excitation. Consequently, this winding B is the exciter winding of the generator. In addition to the shunt winding, which is supplied by the exciter, the stator of the generator has a second compound winding which is supplied from the three-phase circuit of the generator via the selenium rectifier of the current stabilizer TC.

The main excitation flux is set up by the shunt winding, while the compound winding with the stabilizer is designed mainly for maintaining the generator voltage constant with variation in load current.

The generator is not provided with a special device for stabilizing its voltage during variations in supply mains voltage. For this reason radio stations equipped with П-7.2 converters can be installed only where D.C. mains have variations not exceeding ±10 per cent.

Chapter III

PASSAGE OF CURRENT THROUGH THE CIRCUITS OF THE KB-1 TRANSMITTING RADIO STATION

A. TRANSMITTER

The circuit diagram of the transmitter without the rectifier assembly is shown in Appendices 12 and 13 (Appendix 12 shows the radio frequency section of the transmitter circuit, Appendix 13, the circuits of the remote equipment).

The circuit diagram of the radio frequency section of the transmitter is divided into units. Each unit is enclosed by a heavy line. In the diagram the units are arranged in the following order, reading from left to right: 5th, 1st, 2nd, 3rd and 4th. All the supply and control wires approach the units from below. Radio frequency voltages pass from unit to unit by way of special radio frequency contact connections between the units.

Each unit is provided with a terminal strip which is approached by numbered wires. All the supply strips of the units are connected to the main supply strip or to one another.

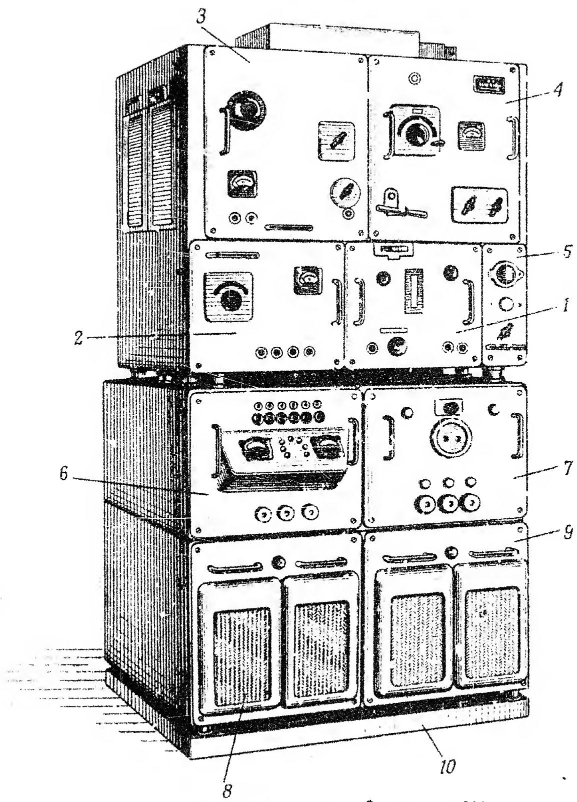

Fig. 36. General View of Transmitter
1—unit No.1; 2—unit No.2; 3—unit No.3; 4—unit No.4; 5—unit No.5; 6—rectifier unit No.1; 7—rectifier unit No.2; 8—rectifier unit No.3; 9—rectifier unit No.4; 10—shock-absorbing frame

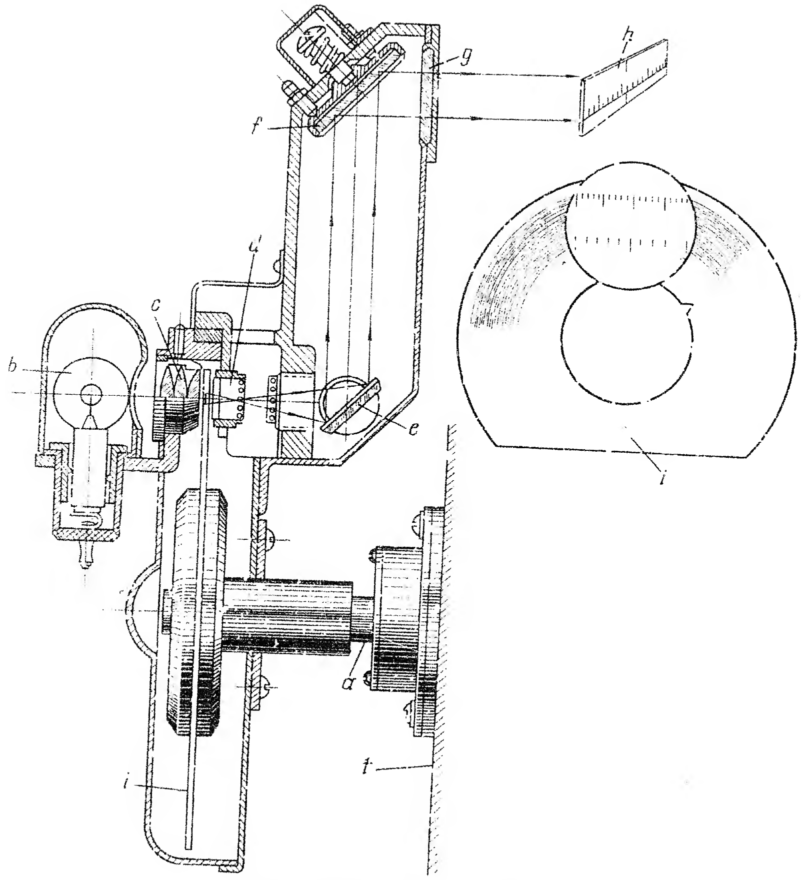

Fig. 37. Optical Dial System

a – shaft; b – dial lamp; c – condenser; d – lens; e – rotating mirror; f – mirror; g – protective glass; h – matte screen; i – photographic dial; t – thermostat

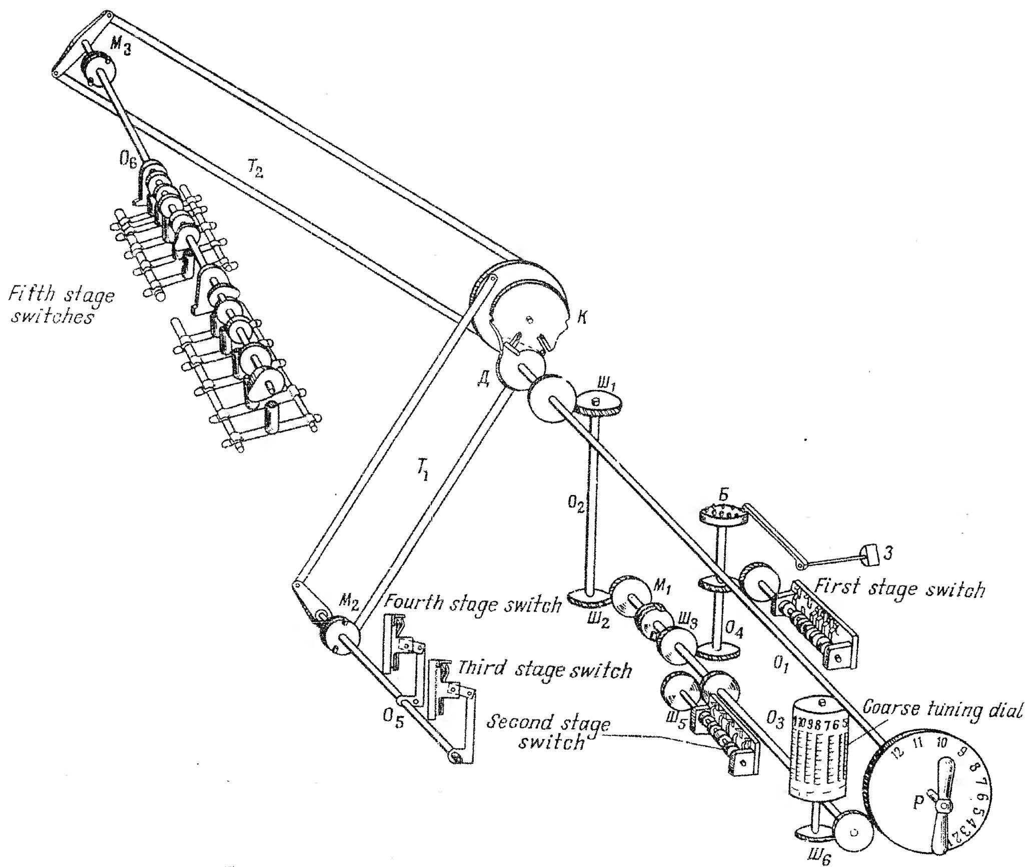

Fig.38. Kinematic Diagram of Band Commutation

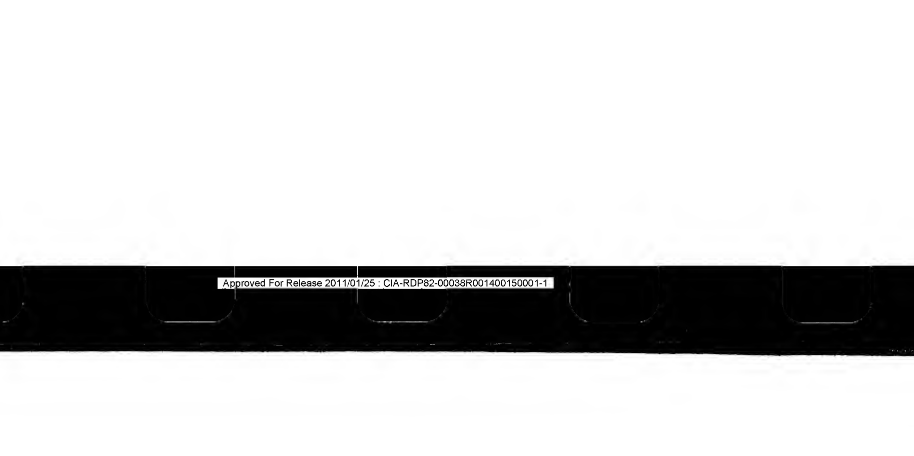

Fig. 39. Tuning Mechanism of Third, Fourth and Fifth Stages

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In the lower left-hand corner of the diagram is shown the circuit of the crystal-heating element when it is supplied from an alternating current mains. Beside it is shown the circuit diagram of the crystal-heating element when it is supplied from a direct current mains.

Below are shown the circuit diagrams of thermostat elements No.1 and No.5, supplied from direct current mains.

The main circuit diagram of the transmitter is shown in the alternating current version. When the transmitter is supplied from D.C. mains, the thermostat circuits are different. These changes in the circuit diagram are shown in the lower part of the circuit diagram of the transmitter (See Appendix 12).

In the lower right-hand corner is shown a detailed diagram of the capacitors of the antenna circuit. All the tuning capacitors of the antenna circuit are made up of type KBKB capacitors of three ratings: C_1 = 27 pF, C_2 = 47 pF, C_3 = 56 pF. The diagram shows how they are connected.

At the right is given a table of the positions of the band selector switch contacts for units Nos 1, 2 and 3 of the transmitter. The left-hand column of each table gives the bands from the first to the twelfth. At the

top are shown the stages where the switches are located, with letters indicating the switch contacts.

A black circle signifies that the contact is closed.

In the table of unit No.1 the switches of the 1st and 2nd stage are closed for the first band. For the second band the switch of the 1st stage has the contacts a, б, г, д closed, while the switch of the 2nd stage has the contacts ж,з closed. Thus, it is possible to determine the positions of the contacts of the switch of any unit and stage for each band. The letters of the contacts can be easily found in the circuit diagram of the units and, with the aid of the table, it is a simple matter to follow the passage of current for the given subrange.

The functions of the wires leading away from the terminal strips of the transmitter are given in Table 6.

Table 6

Wire No.	Function of wire
0	Earth
1, 2	Heater voltage, approx. 12.6 V, A.C.
3	+250 V from rectifier B-2 for supplying screen grids
4	+600 V from rectifier B-5

Wire No.	Function of wire
4^{I} 4^{II}	+600 V after dropping resistor 333 in screen grid circuit of ГУ-80 valves
5	+2500 V, anode voltage for ГУ-80 valves from rectifier B-6
6	Voltage for suppressor grids of 4th stage valves from switch 83 of the control unit
7	-190 V and audio frequency voltage in modulation or earth in CW keying
8	-250 V from rectifier B-4
9	Radio frequency voltage for checking calibration (with heterodyne wavemeter)
10	+24 V of interlock circuit and anode supply for time relay valves
11 12	Heater voltage, approx. 6.3 V, A.C.
13	+24 V to interlock circuit
14	+24 V for controlling H.V. switching circuit when checking frequency
15	Voltage for screen grid of master oscillator valve (from unit No.5)
16	Bias for control grid of buffer stage valve of FM oscillator

Wire No.	Function of wire
18	+24 V from telegraph key to winding of keying relay 307
19	+220 V of stabilized voltage from rectifier B-3
20	See wire No.14
21	+24 V from rectifier B-1
22	+250 V (non-stabilized voltage) from rectifier B-3
23	Anode voltage to valve 1 of master oscillator
24	Telegraph key circuit +24 V to control unit
25^{I}, 25^{II}	To remote resistors of D.C. motor ventilation (of thermostat)
25, 26	Ship's mains for supplying thermostats
27, 28	Heater voltage, approx. 12.6 V A.C., stabilized
41	+24 V for supplying windings of radio frequency relay 23
62	-2500 V
71^{I}	Heater voltage of valve 161, type ГУ-80, after rheostat
71^{II}	Heater voltage of valve 162, type ГУ-80, after rheostat

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Wire No.	Function of wire
71, 72	Heater voltage of ГУ-80 valve
73	Bias voltage for control grid of electronic relay valve
103, 104	Line from jack 81 to output of heterodyne wavemeter

1. Continuous Range Oscillator

In order to facilitate study, the electrical circuit of the continuous range oscillator can be divided into three parts:

1. Master oscillator.
2. 2nd stage (buffer).
3. Electrical circuit of the thermostat.

Master Oscillator

The circuit diagram of the master oscillator is shown in Fig.40.

The master oscillator employs the valve 1, type ГУ-50 in an electron-coupled circuit. The cathode of the valve is heated with alternating current of 12.6 volts, stabilized with the aid of a barretter. The heater voltage is fed via wires 27 and 28. One of the heater wires is earthed directly

at the valve holder, the other lead includes choke 70 and the capacitor 20, which form an R.F. decoupling filter.

The anode of valve 1 of the master oscillator is supplied with stabilized voltage of +220 V via antiparasitic choke 26, anode load choke 22, jack 79 and protection choke 71.

Choke 22, is followed by capacitor 21 which bypasses the A.C. component of the anode of valve 1 to its cathode.

Jack 79 which is shunted by resistor 77 serves for connecting a milliammeter. It should be noted that the resistors shunting the jacks are selected in such a way that the currents of the valve circuits of various stages can be measured without any switching in the instrument itself.

The suppressor grid of valve 1 is earthed (and not connected to the cathode which is at radio frequency potential), in order to obtain additional internal screening between the anode and grid circuit of the master oscillator.

The screen grid of valve 1 is supplied with stabilized voltage of +220 volts via a divider consisting of resistor 25 and resistor 323, located in unit No.5 of the transmitter. In this way a voltage of 90 - 100 volts is applied to the screen grid. The screen grid is earthed for radio frequencies by capacitor 19.

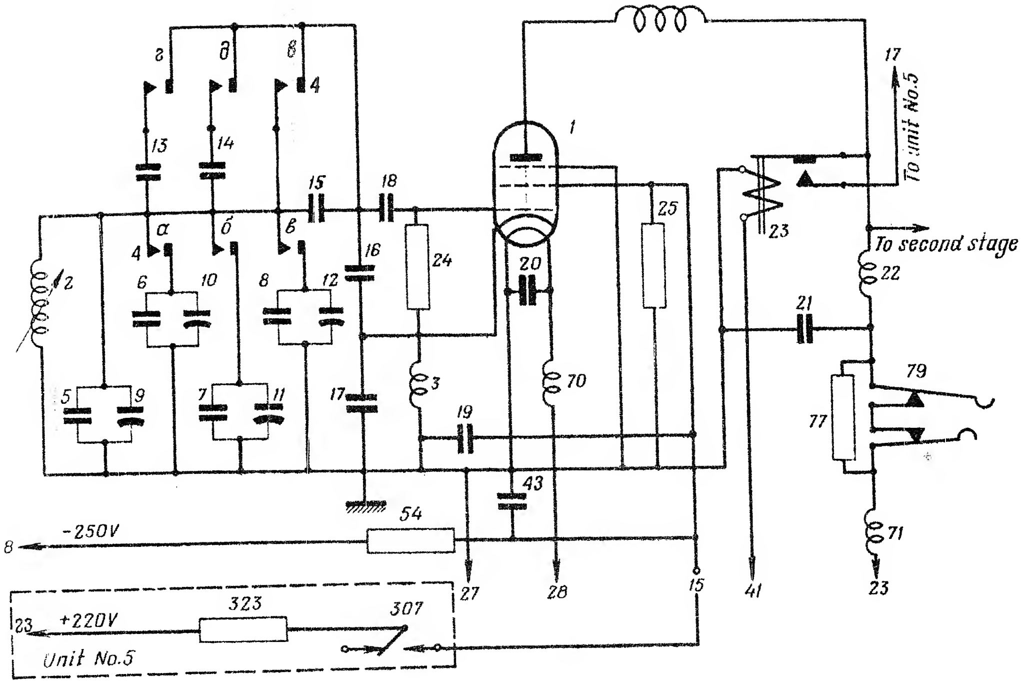

Fig.40. Circuit Diagram of Continuous Range Master Oscillator

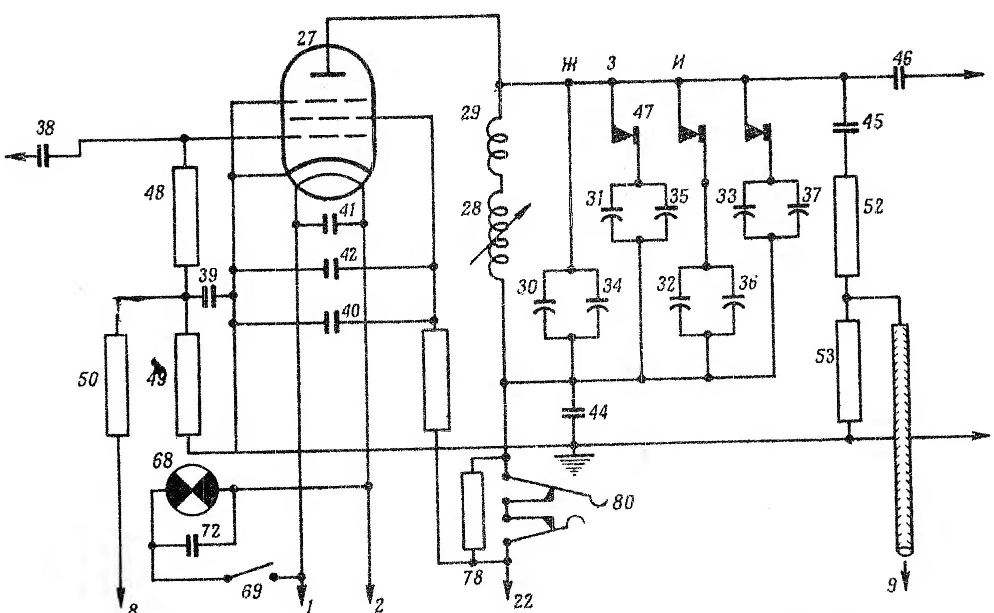

Fig.41. Circuit Diagram of Second Stage of Continuous Oscillator

The cathode of valve 1 is connected to earth via choke 3 which passes the D.C. component of the anode current and the screen grid current.

Bias voltage, supplied to the control grid of valve 1 is developed automatically by the grid current, with the aid of resistor 24.

The continuous range of the master oscillator, which extends from 1.5 Mc/s to 3 Mc/s, is divided into four bands conventionally designated in the text by the letters А, Б, В and Г. Accordignly, the design of the tuned circuit includes switch 4 which varies the capacitance of the circuit by steps, as well as the degree of coupling of the circuit with the valve for various bands.

We shall examine the tuned circuits separately for each band (See Table 4, Chapter II). For band Г (2.5 to 3 Mc/s) the circuit (Fig.40) includes the smallest number of components, for the contacts а, б, в, г, д, е are open.

The circuit consists of variometer 2, fixed capacitor 5 and trimmer 9. The tuned circuit is connected to valve 1 via a capacitive divider consisting of capacitors 15, 16 and 17, with the value of capacitor 15 determining the degree of coupling of the valve to the circuit and the ratio of the values of capacitors 15, 16 and 17, the feedback value.

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On band B (2.1-2.5 Mc/s) the contacts a and г of the band selector switch are closed and, in this way, fixed capacitor 6 and trimmer 10 are added to the circuit, decreasing the frequency of the circuit. Capacitor 13 is connected in parallel to coupling capacitor 15.

On band Б (1.75-2.1 Mc/s) the contacts a and г of the circuit switch remain closed and, in addition, the contacts б and д close.

Capacitor 7 and the third trimmer (11) are connected in parallel with the circuit. Capacitor 14 is connected in parallel with capacitors 15 and 13, increasing the coupling of the valve to the circuit.

On band A (1.5-1.75 Mc/s) the contacts a, г, б and д remain closed and, in addition, the contacts в and е close, fixed capacitor 8 and trimmer 12 are added to the circuit. Capacitors 13, 14 and 15 are short-circuited by the contact е of the switch.

Coupling capacitors 13, 14 and 15 are selected and the coupling of the valve to the circuit changed in such a way as to maintain approximately constant operating conditions of the master oscillator on all bands.

Variometer 2 which is used as the continuous tuning control of the circuit has a coverage of about 1.5 in inductance which provides a working frequency range of the master oscillator from 1.5 to 3 Mc/s in four bands.

Each band is provided with a trimmer. These capacitors make it possible to correct the band dials after replacement of valves, as well as in case of chance violations of the calibration during operation of the station.

It should be noted that after replacement of the master oscillator valve it is usually necessary to adjust all four trimming capacitors. This is due to the fact that the coupling of the valve to the circuit changes on each band, as a result of which the variation in the input capacitance of the valve affects the frequency change of each subrange differently.

Keying of the master oscillator is achieved in the screen grid circuit by applying to the grid a positive voltage of the order of 90 - 100 volts when the key is depressed and a negative voltage of the order of -20 volts when the key is released. The low negative potential of the screen grid is required for complete interruption of oscillation when the key is released.

When the key is depressed, the armature of relay 307 is drawn from the vacant contact to the working contact, closing the +220-volt circuit.

The +220-volt voltage is fed via resistor 323 along wire 15 to the screen grid of the master oscillator valve and resistor 54. Current flowing through resistor 54 is approximately doubled, because the sources of the +220

positive voltage and the -250 negative voltage become connected in series with respect to the circuit consisting of resistors 54 and 323. This causes a redistribution of the voltages at the various sections of the circuit and the screen grid takes on a positive voltage with respect to earth. In this case the master oscillator generates radio frequency oscillations.

When the key is released, the armature of keying relay 307 is drawn to the vacant contact; the +220-volt circuit is broken and the screen grid becomes negative from the divider consisting of resistors 54 and 25. Generation of oscillations is interrupted.

Capacitor 43 serves for smoothing the shape of the telegraph signal.

Unit No.1 of the continuous range oscillator contains radio frequency relay 23, which supplies the valve grid of the second transmitter stage with excitation voltage from the output knife contacts of unit No.5 when operation from the crystal-controlled oscillator is switched to. In this case screen grid voltage is removed from the valve of the continuous range master oscillator by function switch 261 located in unit No.5 of the transmitter, and valve 1 becomes cut off.

The Second (Buffer) Stage

Oscillating voltage from the anode load of master oscillator valve 1 is fed via blocking capacitor 38 to the control grid of second stage valve 27, type П-50 . The circuit diagram of the second stage is shown in Fig.41. As seen from the diagram, the heater of the valve is bypassed by capacitor 41, heater voltage is supplied along wires 1 and 2, the anode of the valve is supplied via tank coils 28 and 29 and jack 80 with shunt 78 for the reference milliammeter.

The screen grid is supplied via dropping resistor 51 and earthed for radio frequencies by capacitor 40. In parallel with this capacitor is connected a small ceramic capacitor (42). The ceramic capacitor does not possess any significant inductance and therefore suppresses the possible development of parasitic oscillations in the screen grid circuit. The suppressor grid of the valve is connected to the earthed cathode.

The control grid of valve 27 is supplied with fixed bias from the -250 volt source via resistor 50, along wire 8. As resistor 50 and resistor 49 form a voltage divider, the screen grid is supplied with a fixed bias voltage of the order of -30 volts. When excitation voltage is applied to the grid, grid current starts to flow, the

value of which is very low, yet it develops additional self-bias for the control grid of the valve across resistor 48, increasing the total bias to -40 volts. Capacitor 39 in the bias circuit forms a decoupling filter in conjunction with the resistors of the circuit. The combined grid bias ensures approximately constant operating conditions for the input circuit of the second stage valve throughout the range, with the key depressed or released.

The second stage always operates as a frequency doubler, covering the frequency range from 3 Mc/s to 6 Mc/s. The anode circuit of the second stage includes a tank circuit tuned to double the frequency of the master oscillator.

The tuning of the anode circuit of the second stage is ganged with that of the master oscillator circuit.

The circuit consists of variometer 28, trimming coil 29 (for aligning the inductive coverage of the variometers), fixed capacitors 30, 31, 32 and 33, trimming capacitors 34, 35, 36 and 37 and band selector switch 47.

Capacitor 44 completes the circuit of the A.C. component of the anode current of valve 27 to the cathode of the valve.

On band Г (5 Mc/s to 6 Mc/s) all the contacts of the tuned circuit switch are open, and the circuit consists of variometer 28, trimming coil 29, fixed capacitor 30 and trimming capacitor 34.

On band B (4.2 Mc/s to 5 Mc/s) contact Ж of switch 47 connects to the circuit fixed capacitor 31 and trimmer 35.

On band Б (3.5 Mc/s to 4.2 Mc/s) contact Ж of the switch remains closed, and in addition contact З closes; fixed capacitor 32 and trimmer 36 are added to the circuit.

On band A (3 Mc/s to 3.5 Mc/s) the contacts Ж and З of the switch remain closed and contact Ж closes; fixed capacitor 33 and trimmer 37 are added to the circuit.

Trimmers are required on each band for fine adjustment of the circuit capacitance for alignment with the circuit of the first stage.

Radio frequency voltage from the circuit of the second stage is applied to the grid of the third transmitter stage valve via blocking capacitor 46. Part of the radio frequency voltage in the grid circuit of the second stage is removed for checking the excitation frequency. For this purpose a voltage divider consisting of resistors 52 and 53 is connected to the anode circuit of the second stage via a small blocking capacitor 45. From this voltage divider radio frequency voltage is taken via screened cable to knife 9 of the oscillator connector.

Parallel to the heater circuit of the second stage (wires 1 and 2) is connected lamp 68 for lighting the optical dial of the oscillator. The lamp is bypassed by capacitor 72. Toggle switch 69 serves for switching on the dial lamp.

The Electrical Circuit of the Thermostat

Radio stations are available in various supply versions, depending on the type of primary supply mains available on the place of installation. These supply versions are reflected in the electrical circuit of the thermostat, as it is supplied directly from the ship's supply mains. The following versions are available:

(a) for D.C. voltages of 220 volts;

(b) for D.C. voltages of 110 volts;

(c) for A.C. voltages of 220 volts;

(d) for D.C. mains of 110 volts with large deviations from the nominal value;

(e) for D.C. mains of 220 volts with large deviations from the nominal value.

We shall examine by turn all the versions of the thermostat circuit. Fig.42 shows the circuit for a D.C. voltage of 220 volts. The mains voltage is supplied via toggle switch 76 to three circuits:

1. To the voltage divider consisting of resistors 58 and 59. From resistor 59 a voltage of about 10 - 12 V is supplied to the winding of relay 67 via contact thermometer-thermoregulator 65.

2. To heating element 63 via resistor 61, contacts of relay 67 and fuse 64.

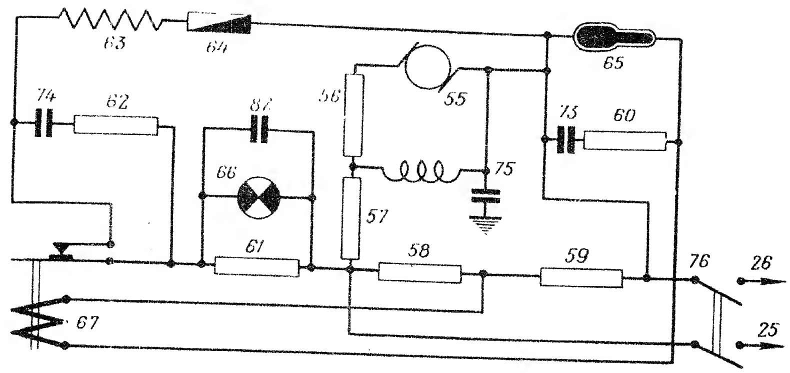

Fig. 42. Thermostat Circuit for Direct Current Mains (220 V)

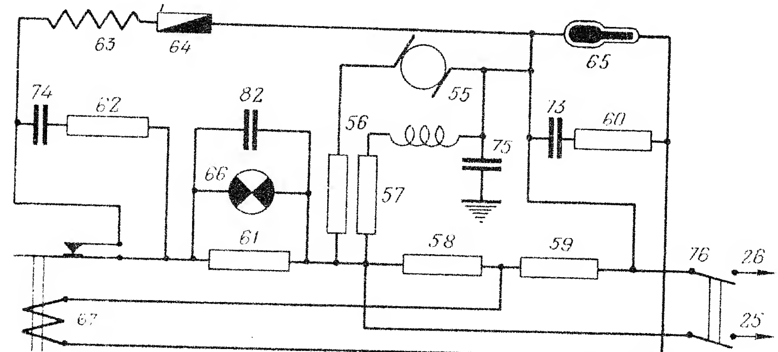

Fig. 43. Thermostat Circuit for Mains with Wide Deviations from Rated Value

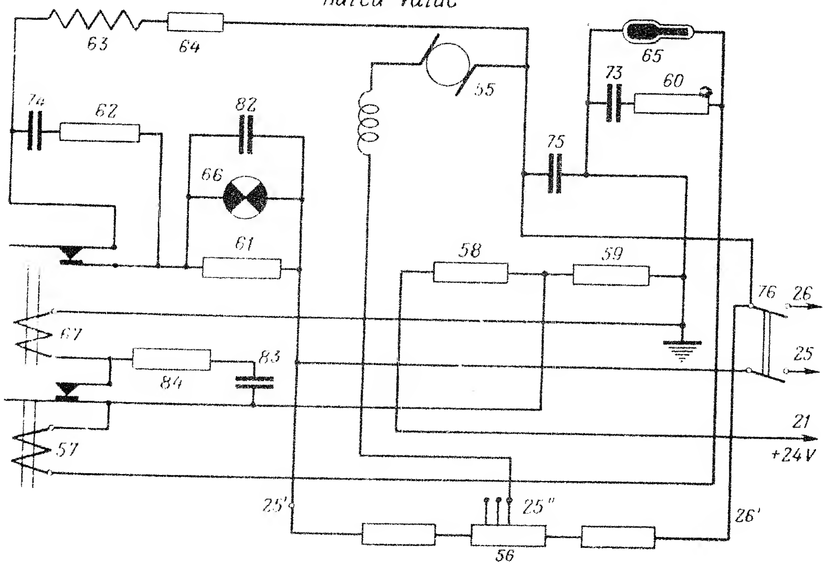

Fig. 14. Thermostat Circuit for Alternating Current Mains of 220 V

3. To fan motor 55, type СЛ-261, of the thermostat. The armature circuit of the motor includes resistors 56 and 57 for reducing the speed of the motor 2-2.5 times with respect to that indicated in the motor certificate. Such connection ensures the required air exchange in the thermostat, at the same time increasing many times the service life of the motor.

Capacitor 75 serves for decreasing the interference produced by the commutator of the motor.

When toggle switch 76 is switched on, fan motor 55 begins to turn, current begins to flow through the circuit of heating element 63, a voltage is developed across resistor 61 and signal lamp 66 lights up. The heat produced by the heating element will gradually increase the air temperature in the thermostat. When the air temperature reaches 60°, the column of mercury in thermal·regulator 65 closes the contact, causing relay 67 to operate, breaking the circuit of heating element 63. Signal lamp 66 goes out. The temperature of the air in the thermostat begins to decrease. On cooling the column of mercury in thermal regulator 65 breaks contact; current no longer flows through the winding of relay 67 and the contact of the relay again closes the circuit of the heating element. The signal lamp again lights up, the thermostat begins to heat up. Thus,

mercury thermal regulator 65 periodically switches the heating element on and off, and the thermostat periodically heats and cools. The fluctuations of the air temperature inside the thermostat do not exceed $\pm 1^{\circ}$.

In order to eleminate sparking the contacts of relay 67 are shunted by a spark extinguishing circuit consisting of capacitor 74 and resistor 62 connected in series. The contacts of the thermal regulator are also shunted by a spark extinguishing circuit consisting of capacitor 73 and resistor 60. Signal lamp 66 is bypassed for radio frequency currents by capacitor 82 connected in parallel.

In order to avoid overheating, the heating element circuit includes a series thermal fuse (64) which fuses at temperatures above 80°, breaking the circuit of the heating elements.

The electrical circuit of the thermostat for operation from a D.C. mains of 110 volts is different in the following respects from the circuit for 220 volts: (a) resistor 57 in the motor circuit is short-circuited; (b) the value of resistor 58 is changed from 5000 ohms to 2500 ohms in order to have the same supply conditions for the circuit of thermal regulator 65; (c) to retain the rated power of the heating element 63 (50 watts), its resistance is decreased four times.

The connection diagram of the thermostat is given in the general circuit diagram of the transmitter (See Appendix 12) for two supply versions. The diagram of unit No.5 presents the A.C. supply version, while the version for a D.C. supply is given below.

The Buffer-Amplifier Stage

The buffer-amplifier stage (Fig.45) employs valve 300, type ГУ-50. The load in the anode circuit of valve 300 is choke 22, located in unit No.1, which also serves as the load of continuous range master oscillator valve 1. Choke 22 is connected to the anode of valve 300 via radio frequency knife contact 17 and the contact of relay 23. The control grid of valve 300 is supplied via contact 16 with negative bias from potentiometer 144 located in unit No.2. Choke 301 and capacitor 302 protect the bias circuit from radio frequency currents. Voltage is supplied to the screen grid from the potentiometer, formed by resistors 305 and 306, to which +220 volts are applied via switch 261B.

The Electronic Relay

The electronic relay (Fig.45) employs two valves 287 and 290, type 6H7. The windings of keying relay 298 are connected to the anodes of valve 287. The contacts of relay 298 short or unshort deviation choke 265 connected

in series with crystal 263, which provides frequency-shift keying of the crystal oscillator in printing telegraphy.

Resistors 288, 289, 292, 293, 294 and 295 are the load resistors of valves 287 and 290, forming together with the latter the electronic relay circuit. Anode voltage is supplied to the electronic relay valves from the +220-volt stabilized voltage source via switch 261B (in positions 3 and 4). Negative bias voltage is applied to the control grids of valve 287 and the left triode of valve 290 from potentiometer 144 via contact 73. The negative bias voltage of -8 volts for the grid of the right triode of valve 290, which is the input triode of the electronic relay, is supplied via resistors 291 and 274 from the potentiometer consisting of resistors 325, 326 and 327. The control grid circuit of the right input triode of valve 290 includes resistor 327 across which 8 volts are dropped. Resistor 274 is the input resistor of the electronic relay across which voltage is developed by the linear current of the operating telegraph set.

3. The Amplitude Keying Relay of the Transmitter

Amplitude keying in manual telegraph operation is achieved with the aid of keying relay 307 (Fig.45). Depending on the mode of operation chosen, keying is achieved either by cutting off and opening valve 1 of the continuous

range oscillator or valve 262 of the frequency-shift keying oscillator.

Keying relay 307 has two windings. One end of each winding is connected to the chassis of the transmitter. The armature of the relay is drawn either to the left or right contact, depending on which of the windings has a predominence of current. The right-hand winding of the relay is always supplied with +24 volts (contact 21) via resistor 316. Thus, when there is no current in the left-hand winding, the armature of the relay is always at the right-hand (vacant) contact. The armature is drawn to the left (working) contact by applying +24 volts to the left-hand relay winding. This voltage is applied, when telegraph key 99 is depressed, along wire 18 via switch 261б (in positions 2 and 3) and resistor 317. As resistor 317 has a lower value than resistor 316, the current in the left-hand winding will be higher than that in the right-hand winding, and the armature of the relay will be drawn to the left contact. In parallel with the contacts of key 99, is connected push-button 322 of unit No.5, which duplicates the operation of the key. The working contact of the armature of relay 307 is constantly supplied with +220 volts (contact 19) via resistor 323. Depending on the position of switch 261a, the left (working) contact of the relay is connected either to the screen grid of valve 1 or to the screen grid of

valve 262. Resistor 315 and the capacitor 308 form the spark-extinguishing circuit of the working contact of the relay. Chokes 318, 319, 320 and 321 and capacitors 309, 311, 313, and 314 form a filter which serves for attenuating the interference produced by the relay contact when keying.

4. Selection of the Operation Mode of the Transmitter

The operating modes of the transmitter are selected with the aid of switch 261, located in unit No.5.

The switch has the following four positions:

(a) first position: CHECKING (КОНТРОЛЬ);

(b) second position: CONTINUOUS RANGE (ПЛАВНЫЙ ДИАПАЗОН);

(c) third position: CRYSTAL (КВАРЦ);

(d) fourth position FREQUENCY-SHIFT KEYING OSCILLATOR (ВЧМ) (crystal-controlled frequency-shift keying operation).

Switch 261 has four wafers designated in Fig.45 by numbers 261, 261a, 261б and 261в.

We shall examine in detail all the circuits formed by switch 261, separately for each position.

First position - CHECKING. In this position the calibration of the continuous range master oscillator is checked. Valve 1 of the master oscillator of the continuous range

oscillator is supplied with a normal voltage of +220 volts from the stabilized rectifier via wafer 261 and contact 23. The screen grid of valve 1 is also supplied with a working voltage of +220 volts via resistor 323, wafer 261a and contact 15, bypassing the contacts of keying relay 307. In the position CHECKING, wafer 261B breaks the supply circuit of the high-voltage contactors (wires 14 and 20 are disconnected), as a result of which all high voltage is removed from the transmitter with the exception of the supply voltage of the master oscillator and the second stage. Thus, in the position CHECKING only valves 1 and 27 operate. The key does not operate in this position.

The second position - CONTINUOUS RANGE. In this position the transmitter operates from the continuous range oscillator. Valve 1 of the continuous range master oscillator is supplied with a normal voltage of +220 volts from the stabilized rectifier (contact 19) via wafer 261 and wire 23. The screen grid of the valve is connected by wire 15 via wafer 261a to the armature of keying relay 307, the working contact of which is constantly supplied with +220 volts via resistor 323. When the armature is at the working contact, +220 volts are supplied to the screen grid of valve 1. When the armature is drawn to the vacant contact, valve 1 is cut off by the negative voltage which is constantly supplied from the rectifier B-4 (-250 volts) via resistor 54.

Constant bias voltage is supplied to the control grids of valves 114 and 115 from potentiometer 144. Additional self-bias is developed across resistors 140 and 139 by the grid currents of the valves. The grid bias circuit is bypassed by capacitor 122. Resistor 139 is not bypassed, as a result of which radio frequency voltage is distributed partly across choke 96 and partly across this resistor.

With decreased frequency, the excitation voltage increases, with a corresponding increase in the voltage drop across resistor 139. At the same time, the voltage across choke 96 decreases, as the inductive reactance of the choke decreases. As a result the excitation voltage is levelled out to a certain degree throughout the range.

With parallel connection of the two valves, the wire connecting the control grids possesses considerable inductance which, together with the input capacitance of the valves and the parasitic capacitance of the circuitry, forms a tuned circuit. Under certain conditions, the parasitic coupling between the control grid circuits and other circuits of the stage can cause parasitic oscillations (self-oscillations) to occur in this tuned circuit. To suppress these oscillations, inductionless anti-parasitic resistors 137 and 138 are connected directly at the control grid leads of the fourth stage valves.

Excitation voltage is fed to the control grids of the fourth stage valves via blocking capacitor 104. Supply voltage is fed to the screen grids of the fourth stage valves from the rectifier B-2 (+250 volts) via resistor 141. The screen grids are bypassed by capacitors 123 and 124. The suppressor grids of the fourth stage valves are connected via terminal 6 to potentiometer 82 located in the control unit. With the aid of switch 83 various negative voltages can be supplied to the suppressor grids, in this way regulating the power output of the transmitter. The suppressor grids are bypassed by capacitors 125 and 126.

D.C. voltage (+600 V) is supplied to the anodes of the fourth stage valves from the rectifier B-5 via anode choke 120. The anode supply circuit is bypassed by capacitors 134 and 133. The control-grid and anode circuits are provided with jacks 148 and 149 (jack 149 is not shown in Fig.47). The anode circuit of the fourth stage is tuned with the aid of a variable inductance consisting of two variometers 116 and 117; on all bands the rotor and stator of each variometer are connected in parallel.

On the first and second bands, fourth-stage variometers 116 and 117 are connected in series, and on the third band in parallel.

The inductive leg of the circuit includes the capacitor 130 connected in series with the variometers, from which excitation voltage for the control grids of the fifth stage valves is taken. When switching over bands, in addition to switching the variometers, the circuit capacitance is also varied.

On the third band (12 to 24 Mc/s), the contacts Д and Ж of switch 152 are closed, the rest of the contacts remaining open. In this case the tank circuit consists of the capacitance of the circuitry and valves, trimmer 132, capacitor 130, the variometers 116 and 117, and trimming coils 118 and 119. The tank circuit of the third band is shown in Fig.48,a.

On the third band the inductance and capacitance of the circuit are at minimum value, as capacitors 132 and 130 are connected in series, and the circuit inductances connected in parallel.

On the second band (6 to 12 Mc/s) the contacts е and И of switch 152 are closed, the rest of the contacts remaining open. Now the tuned circuit consists of the capacitances of the circuitry and valves, capacitors 132, 130 and 129, as well as of two variometers 116 and 117 and trimming coil 118 connected in series. The tank circuit of the second band is shown in Fig.48,b. The inductance of

the circuit has increased approximately four times (due to series connection of the variometers and trimming coil 118), while the capacitance has increased due to the parallel connection of capacitor 129. Excitation voltage is fed to the control grids of the fifth stage valves from capacitor 130.

On the first band (3 to 6 Mc/s), switch 152 closes the contacts г, е and з, the rest of the contacts remaining open. Now the tuned circuit consists of the capacitances of the circuitry and capacitors 132, 128, 127 and 130, as well as of two variometers 116 and 117 and trimming coil 118. The tuned circuit of the first band is shown in Fig.48,c. Excitation voltage for the control grids of the fifth stage valves is supplied in this case from two parallel-connected capacitors 127 and 130.

On all three bands of the fourth stage, the trimming capacitors and trimming coils serve for adjusting the initial capacitance and initial inductance of the tuned circuit, which is necessary for aligning the tuning of the transmitter. The value of the trimming capacitors and coils is selected during alignment of the transmitter at the factory, and is not varied subsequently.

7. The Fifth Transmitter Stage

The fifth, output stage of the transmitter (Fig.49) operates as an amplifier. The stage employs two series-fed

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transmitting pentodes 161 and 162, type ГУ-80. The ГУ-80 valves have directly-heated cathodes. The filaments have centre taps which are earthed. To protect the valve cathodes from radio frequency currents, the heater circuit includes chokes 165, 167 and capacitors 186, 187, 188 and 189.

Heater voltage is fed from terminals 71 and 72 via rheostats 331 and 332 located in the transmitter cabinet.

Bias voltage for the control grids of the П-800 valves is supplied from grid bias potentiometer 144 located in unit No.2, via milliammeter 150, bypassed by capacitor 147, resistor 143, choke 121 and anti-parasitic chokes 163 and 164. Resistor 143 and choke 121 level out the excitation voltage, similarly to the way this is done by components 96 and 139 in the grid circuit of the fourth stage valves.

The grid bias supply circuit is bypassed by capacitor 135 and 136. The control grids of the fifth stage valves are coupled to the anode circuit of the fourth stage via blocking capacitor 131. Capacitor 131, choke 121, resistor 143 and capacitor 136 are housed in the second unit of the transmitter. In order to prevent the development of parasitic oscillations, the silit resistors 205 and 206, bypassed by anti-parasitic chokes 163 and 164, are connected directly at the control grid leads of each

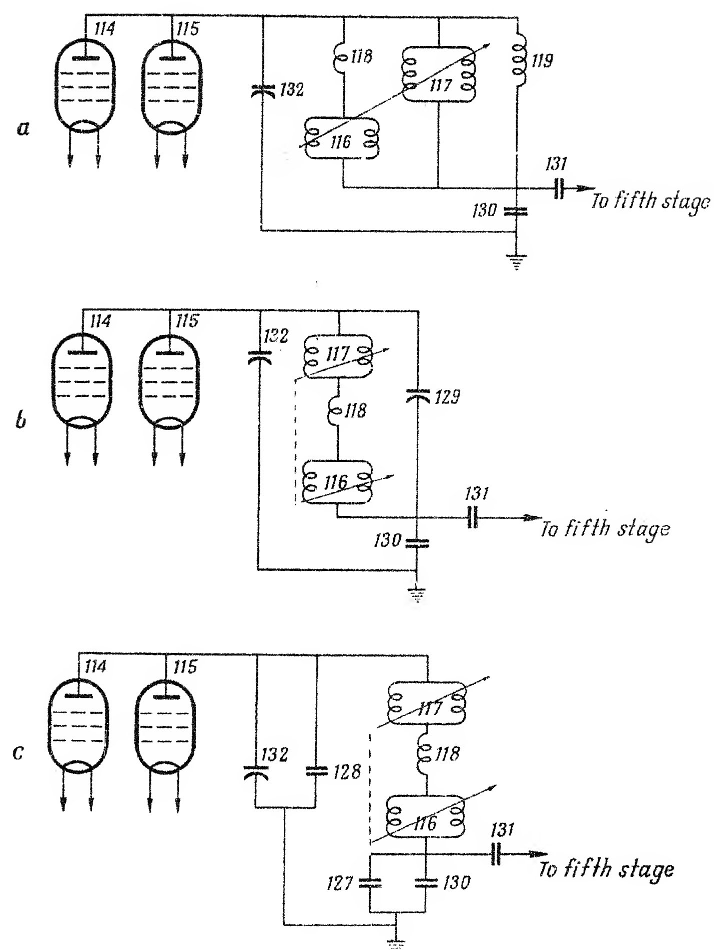

Fig. 48. Simplified Circuit Diagram of Fourth Stage Tank Circuit

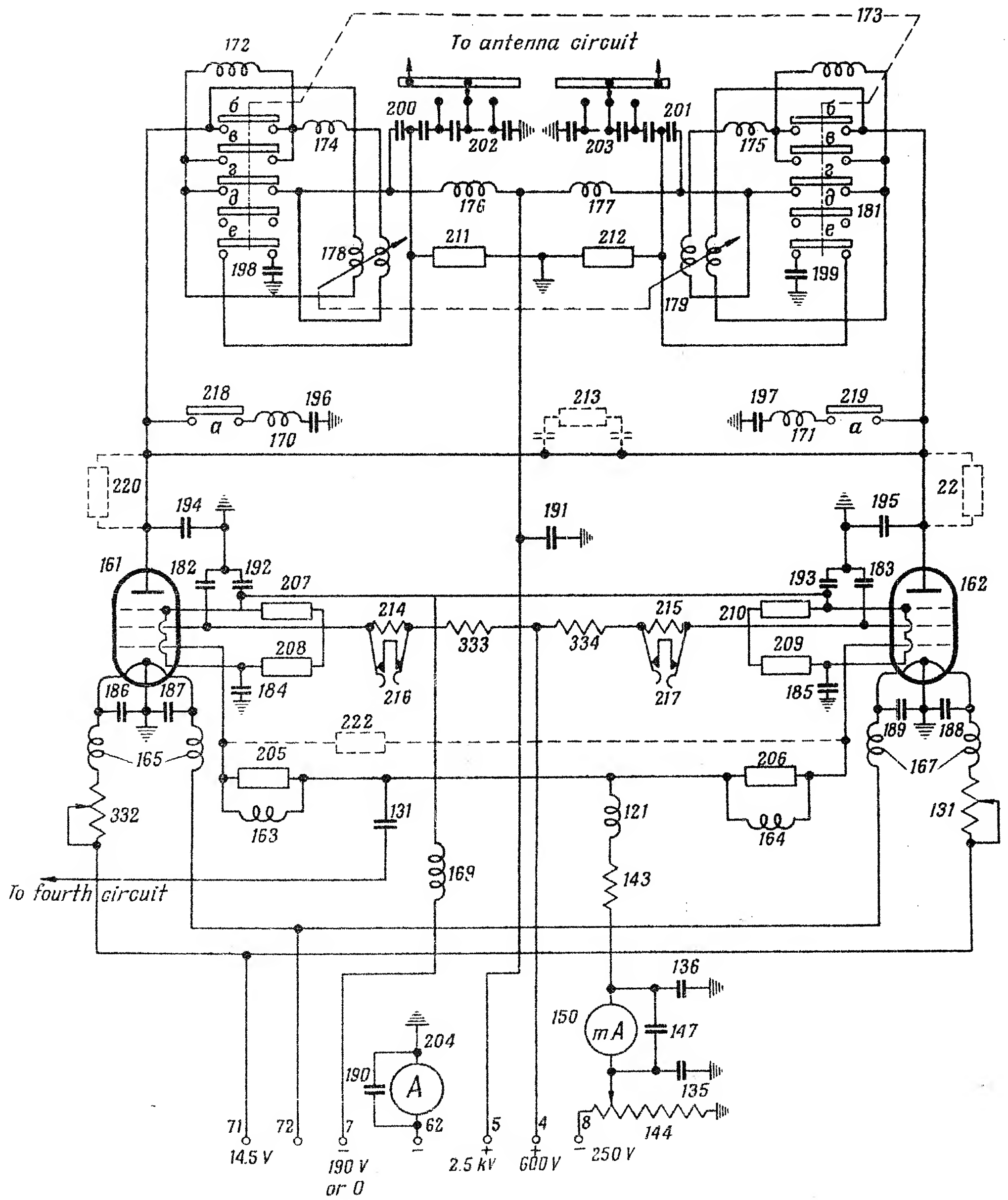

Fig.49. Circuit Diagram of Fifth Stage

valve. Anti-parasitic resistors 205 and 206 increase the attenuation of the grid circuit for parasitic oscillations in the ultra short wave range. The anti-parasitic chokes serve for passing the D.C. component of the grid current and the working frequency current in the control grid circuit. For USW parasitic oscillations which may occur in the grid circuit, the anti-parasitic chokes present a very high resistance. For this reason the currents of parasitic ultra short wave oscillations must flow through resistors 205 and 206 which introduce high attenuation into the grid circuit and hinder self-oscillation of the stages on ultra short waves.

Resistor 222 (shown in Fig.49 by a dotted line) which is connected directly between the control grids, also increases the attenuation of the grid circuit for parasitic oscillations.

The screen grids of the valves are supplied with +600 volts from rectifier B-5 via resistors 333 and 334, which limit the screen grid current. For radio frequencies the screen grids are earthed by means of blocking capacitors 182 and 183.

Both the upper and lower leads of the suppressor grids of each valve are bypassed by capacitors 192, 184, 185 and 193. The suppressor grids are supplied via choke 169. In telegraph operation, the suppressor grids are at zero

electrical strength of the insulation of these capacitors is intended to withstand the full anode voltage of the stage.

The direct anode voltage of the output stage valves is distributed between blocking capacitors 200 and 201 and coupling potentiometer capacitors 202 and 203, directly proportional to the insulation resistance of these capacitors. If the insulation resistance of the capacitive potentiometer capacitors commensurable with the insulation resistance of the blocking capacitors, then a high D.C. potential may develop across the capacitive coupling potentiometer, for which it is not designed. In order to eliminate high D.C. potential across the capacitors of the coupling potentiometers, 470,000-ohm resistors 211 and 212 are connected across each of them. As the value of these resistors is much lower then that of the insulation resistance of blocking capacitors 200 and 201, all the anode voltage is applied to these capacitors, the D.C. voltage across the coupling potentiometers being sharply reduced. Thus, resistors 211 and 212 serve for unloading the coupling potentiometer capacitors of the D.C. voltage applied to the anodes of the fifth stage valves.

Switching of the tank circuits of the fifth stage is obtained by means of two switches 180, 181 and contactors 218 and 219, which symmetrically switch the circuit components

of the various bands. In the third band of the fifth stage (12-24 Mc/s) the contacts б and Г are closed with the aid of the switches, the rest remaining open. The anode circuit for the third stage is shown in Fig.50,a.

The tank circuit of valve 161 consists of trimming coils 172, 174, variometer 178, capacitors 194, 200 and capacitive potentiometer 202. The tank circuit of valve 162 consists of trimming coils 173, 175, variometer 179, capacitors 195, 201 and capacitive potentiometer 203.

Both tank circuits include the capacitances of valves and the circuitry. On the third band the capacitance and inductance of the tank circuits is at minimum, as all the capacitors are connected in series and all the inductance, in parallel. Trimming coils 172 and 173 serve for adjusting the frequency coverage of the tank circuits. In the third band, as well as in the other band, the antenna circuit is coupled with the aid of capacitive potentiometers 202 and 203. Each capacitive potentiometer is made up of 12 mica capacitors connected in series. The taps of the capacitors are connected to the switch which provides 11 steps of antenna coupling.

On the second band of the fifth stage (6 to 12 Mc/s), the contacts В are closed, the rest remaining open. In this case the tank circuit of valve 161 consists of trimming

coil 174, variometer 178, capacitors 194, 200 and capacitive potentiometer 202 (Fig.50,b). The tank circuit of valve 162 consists of trimming coil 175, variometer 179, capacitors 195, 201 and capacitive potentiometer 203. Both tank circuits include the capacitance of valves and the circuitry.

On the second band of the fifth stage inductance is increased as a result of series connection of the rotors and stators of the variometers and one of the trimming coils. The capacitance of the tank circuit has remained the same as in the third band. Coils 174 and 175 serve for adjusting the frequency coverage of the tank circuits.

In the first band of the fifth stage (3 to 6 Mc/s) the contacts а , в , д , е are closed, the rest remaining open. Now the tank circuit of valve 161 is formed by trimming coils 174, 170, variometer 178, capacitors 194, 196, 198, 200 and the capacitive potentiometer 202 (Fig.50,c). The tank circuit of valve 162 is formed by trimming coils 171, 175, variometer 179, the capacitors 195, 197, 199, 201 and capacitive potentiometer 203.

In the first band, the inductance included in the anode circuit of each valve remains approximately the same as in the second band. The capacitances of the tank circuits are increased by the addition of fixed capacitors 196 and 197. In addition, capacitors 198 and 199 are connected in parallel

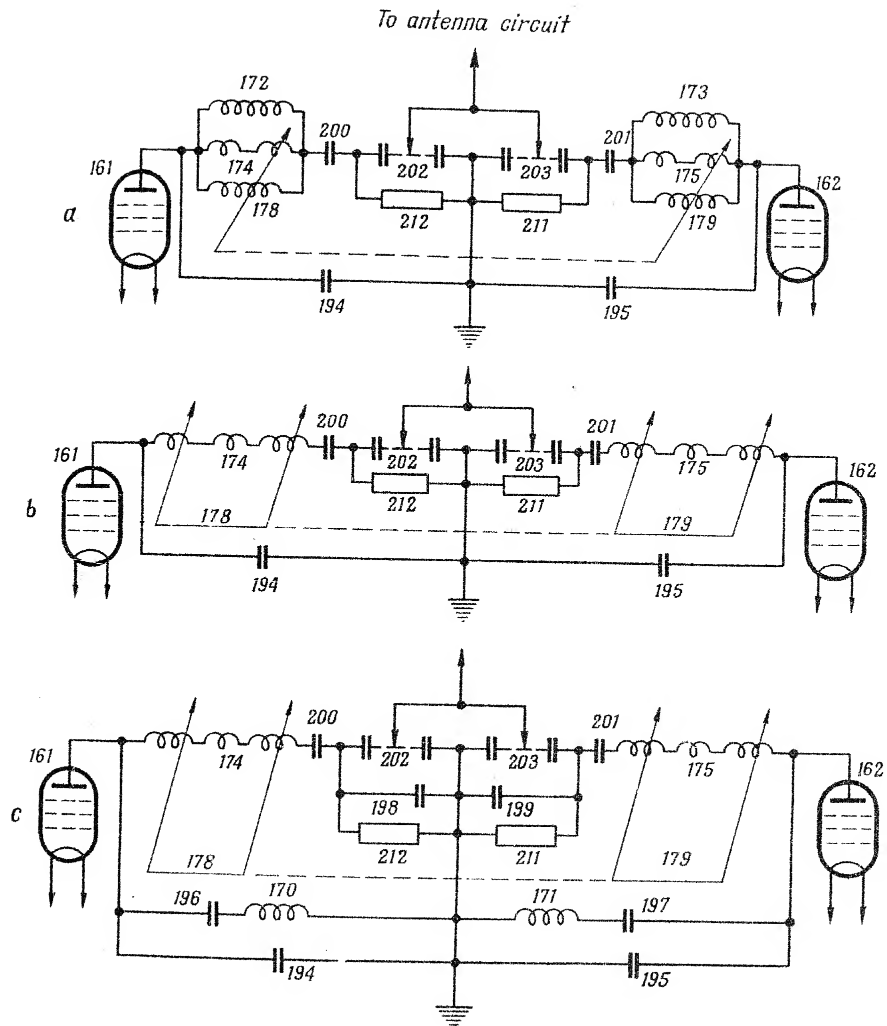

Fig. 50. Simplified Diagram of Fifth Stage Tank Circuit

with the coupling potentiometers. Trimming coils 170 and 171, connected in series with capacitors 196 and 197, serve for adjusting the frequency coverage of the tank circuit in the band.

8. The Antenna Circuit of the Transmitter

The antenna circuit of the transmitter (Fig.51) is housed in unit No.4 and consists of continuously variable inductance coil 231, a group of capacitors 237, 238, 239 connected in series with the inductance coil, and a group of capacitors 240, 241, 242, 243 and 244 connected in parallel with the antenna input. The number of turns of coil 231 is varied with the aid of the knob located on the front panel of unit No.4, marked ANTENNA CIRCUIT INDUCTANCE (ИНДУКТИВНОСТЬ АНТЕННОГО КОНТУРА).Connection in circuit of any combination of either series- or parallel-connected capacitors is achieved by means of switches 232 and 233 marked SERIES (ПОСЛ.) and PARALL. (ПАРАЛЛ.) respectively.

The switch of series-connected capacitors 232 has five positions, allowing operation without any capacitors (position 4), with capacitor 239 connected in series (position 3), with two capacitors 239 and 238 connected in series (position 2), or with three capacitors 239, 238 and 237 con-

nected in series (position 1). If necessary, the antenna can be earthed. For this the switch is set in position 5.

Switch 233 connects capacitors 240, 241, 242, 243 and 244 in parallel with the antenna input.

Optimum coupling of the anode circuit of the fifth stage with the antenna circuit is selected with the switch marked ANTENNA COUPLING (СВЯЗЬ С АНТЕННОЙ), which has 11 positions. In the first position of the antenna coupling switch, the coupling is at minimum, in the eleventh position, coupling is at maximum.

Tuning of the antenna circuit is monitored with the aid of two current transformers 246 and 247, which are coupled with the wires leading to the coupling potentiometers. The radio frequency currents developed in the secondary windings of the transformers are rectified by double diode 245, type 6X6. The rectified current causes the pointer of meter 234 to deflect. D.C. meter 234 is bypassed for radio frequencies by capacitor 235. In order to decrease the effect of frequency on the readings of the indicator, the windings of transformers 246 and 247 are shunted by resistors 248 and 249. Resistor 250 serves as the diode load. Capacitor 236 bypasses the cathode circuit and the meter 234.

In addition to the antenna tuning indicator, the readings of which are proportional to the current in the

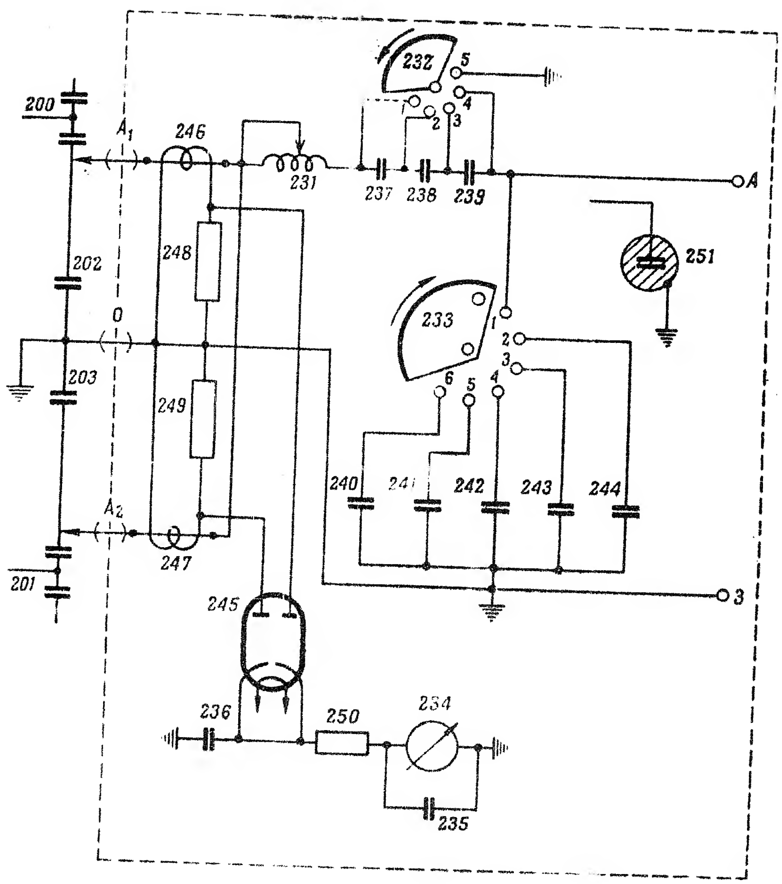

Fig.51. Circuit Diagram of Antenna Circu..

antenna circuit, the transmitter is provided with an additional indicator, a neon lamp (251), located on the front panel of unit No.4 of the transmitter.

As the transmitter can be used for operation into various types of antennas, the coupling between the neon lamp and the antenna circuit should be selected at the place of installation of the transmitter during initial tuning.

B. REMOTE EQUIPMENT

Appendix 13 shows the basic circuit diagram of the remote control equipment: the remote communication post with the amplifier and dynamic loudspeaker connected to it, the control unit with the modulator, and the radio operator's post. A separate diagram of the modulator heater circuit is also given.

The modulator employs valves with heater voltages of 6.3 and 12.6 volts, with the 6.3-volt valves connected two in series. The functions of wires are given in Table 7.

Table 7

Wire No.	Function of wire
0	Earth
1, 2	Heater voltage, 12.6 volts

Wire No.	Function of wire
3	+250 V from rectifier B-2 for supplying screen grids
4	+600 V from rectifier B-5
6	Voltage for screen grids of fourth stage valve from switch 83 of control unit
7	-190 V and audio frequency voltage in modulation or earth in CW operation
8	-250 V from rectifier B-4
13	+24 V to interlocking circuit
13[1]	Interlocking circuit from control unit to modulator
18	+24 V of keying circuit
20	+24 V control voltage for disconnecting H.V. when checking frequency
21	+24 V from rectifier B-1
24	+24 V keying circuit from transmitter
101, 102	Microphone supply circuit
106	+250 V for anodes of modulator valves
107	+24 V keying circuit from control unit to keying relay of tone generator
109	+24 V control voltage to control unit to semi-duplex relay

Wire No.	Function of wire
110	-190 V to modulator
111	+250 V to anode of tone generator
112	+250 V to anode of first modulator valve
114	+24 V circuit of H.V. signal lamp
115	+24 V from push-button START (СТАРТ) to heater contactor
116	+24 V circuit to relay 76 to relay 90 in control unit
117	Audio frequency voltage and -190 volts from modulator output control unit
A	High in voltage signalling system
Б	Supply for +24 V control circuit
В	Transmitter starting circuit and heater signalling system
Г	Transmitter stopping circuit
Д	H.V. switching-on circuit
Е	Keying circuit (+24 V) of telegraph key or press-to-talk lever
Ж	Microphone supply and modulator input circuit
З	Return circuits of all lines (earth)
И	Microphone supply circuit for internal communication

Wire No.	Function of wire
К, Л	Headphones and receiver output circuit
М	Supply circuit of control unit microphone
Н	Calling circuits and call signalling system
О, Р, Я	Receiver control line from semi-duplex relay
НР	Two wires to receiver output
ДТ	Two wires to additional telephone
КЛ	Middle contact of key
УС	To amplifier with loudspeaker

This section will deal with each unit of the remote equipment separately. The more complicated circuits will be dealt with separately together with their associated components located in various parts of the transmitting radio station.

1. Modulator Assembly

The following is assembled on the modulator chassis (Fig.52):

(a) a three stage audio frequency amplifier (modulator) with automatic gain control and a modulation depth indicator;

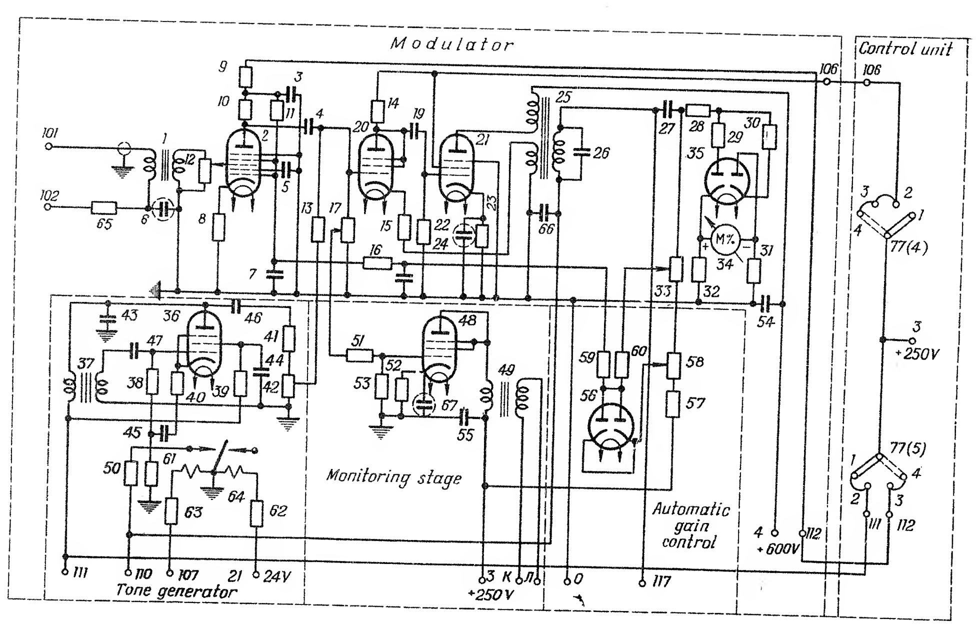

Fig.52. Modulator Circuit

(b) stage for monitoring operation of the transmitter;

(c) tone generator.

The audio frequency amplifier (modulator) consists of a microphone amplifier, an intermediate amplifier stage and a power amplifier.

The microphone amplifier employs valve 2, type 6SA7, (6А15Б).

Audio frequency voltage from the microphone is fed via terminal 101 to the primary winding of input transformer 1. The other end of the primary winding of this transformer is bypassed to earth for audio frequencies by capacitor 6, and is insulated from the chassis for direct current and connected via dropping resistor 65 to terminal 102. The secondary winding of the microphone transformer is loaded by resistor 12 which is the input gain control, knob MODULATION DEPTH (ГЛУБИНА МОДУЛЯЦИИ). Audio frequency voltage from the slider of this resistor is applied to the third grid of valve 2. Bias is supplied to this grid by the voltage drop across cathode resistor 8.

Voltage is supplied to the second and fourth grids of valve 2 along wire 3 from rectifier B-2 via switch 77 in the control unit, wire 112 and resistors 9 and 11. Resistor 9 and capacitor 3 form a decoupling circuit designed for preventing self-excitation of the input stage of

the modulator. Resistor 10 serves as the anode load of valve 2.

The second and fourth grids are connected to the chassis via capacitor 5. The fifth grid is connected to the chassis directly. The first grid of valve 2 is supplied with automatic gain control (AGC) voltage. This voltage is supplied from the anode of valve 56 via a smoothing filter consisting of resistors 59 and 16 and capacitors 18 and 7. The first grid is earthed for audio frequencies by capacitor 7. Audio frequency voltage is applied from resistor 10 via blocking capacitor 4 to the grid of the second stage valve (20) of the modulator.

Valve 20, a type 6SJ7 pentode, operates as a triode (its anode, screen grid and suppressor grid are connected together). In tone modulated operation audio frequency voltage is applied to the grid of valve 20 and potentiometer 17 from the tone generator via resistor 13.

From potentiometer 17 audio frequency voltage is supplied to the input of the monitoring stage. The bias voltage for the control grid of valve 20 is obtained by the voltage drop across cathode resistor 15. The anode of valve 20 is supplied with +250 volts from rectifier B-2 along the following circuits: wire 3 of the control unit, function switch 77, wire 106 of the modulator and resistor 14. Audio frequency voltage from anode resistor 14

is applied via blocking capacitor 19 to the control grid of modulator output valve 21.

Resistor 22 serves as a grid leak in the control grid circuit of valve 21. Bias voltage is applied from resistor 23 included in the cathode circuit of valve 21. For audio frequencies the cathode of the valve is bypassed to earth by capacitor 24. The screen grid of valve 21 is supplied with +250 volts from rectifier B-2 along wire 106.

Anode voltage of +600 volts is supplied from rectifier B-5 along wire 4 via the primary winding of output transformer 25. The secondary winding of transformer 25 is connected via the closed contact of switch 77 (in the control unit) to the suppressor grids of the output stage valves of the transmitter. Capacitor 26 connected in parallel with the secondary winding of the transformer is intended for cutting down high frequency. Capacitor 66 earths one end of the secondary winding of transformer 25 for audio frequency currents. The last two stages of the modulator use a negative feedback circuit. Feedback voltage is taken from a special winding of transformer 25 and introduced into the cathode circuit of the second stage valve (20) via resistor 15.

Capacitor 27 separates the D.C. circuit of the winding of transformer 25 from the audio frequency circuit of the

modulation depth indicator valve 35 and automatic gain control valve 56. Audio frequency voltage from the secondary winding of transformer 25 is fed to potentiometer 33 which regulates the rate of compression. Audio frequency voltage is fed from the slider of this potentiometer to the anodes of diode 56, type 6X6, via resistor 60. The voltage rectified by the diode is fed via a smoothing filter to the first grid of valve 2, decreasing the gain of the valve the greater, the higher the voltage at the output of the modulator. Delay voltage is taken from the potentiometer consisting of resistors 57 and 58. This potentiometer is supplied with +250 volts from rectifier B-2 via terminal 3.

A valve voltmeter serves for monitoring the modulation depth of the transmitter. The voltmeter employs double diode 35, type 6X6. Audio frequency voltage is applied to the anodes of the diodes in anti-phase from the secondary winding of transformer 25. The loads of the valve diodes are resistors 29, 30, 31 and 32.

1-mA milliammeter 34 serves as a pointer meter.

The tone generator employs pentode valve 36, type 6Ж8. The tone generator is a self-excited stage employing a transformer feedback circuit. The tuned circuit in the anode stage of the valve is formed by a winding of transformer 37 and capacitor 43. The feedback winding is con-

nected to the grid circuit via blocking capacitor 47. In order to improve the shape of the generated voltage, negative feedback is employed, which is developed across resistor 40, the latter being included in the cathode circuit of the valve. The control grid of oscillator valve 36 is supplied via resistor 38 with a high negative voltage of the order of 135 volts, which completely cuts off the valve. When the key is depressed, relay 64 operates, and its contacts remove the negative voltage from the grid of the valve by connecting the junction of resistors 38 and 50 to earth. The generator now begins to operate.

Anode and screen-grid voltage is supplied to the tone generator valve from rectifier B-2 via switch 77 (in the control unit) along wire 111. Resistor 39 serves for dropping the voltage applied to the screen grid.

From the anode of valve 36, tone frequency voltage is taken via capacitor 46 and resistor 41 to potentiometer 42. From potentiometer 42, tone frequency voltage is fed via resistor 13 to the control grid of valve 20 (for amplification and modulation of the transmitter in tone telegraphy operation). Simultaneously, from potentiometer 17 tone frequency voltage is fed to the grid of valve 48 for monitoring the keying of the transmitter.

The monitoring stage employs valve 48, type 6Ж8, which is connected as a triode. The valve is provided

with bias voltage by the voltage drop across cathode resistor 52, which is bypassed by capacitor 67. From potentiometer 17 the control grid of the valve is supplied with part of the audio frequency voltage taken from the grid of valve 20. The anode circuit of valve 48 includes transformer 49, whose secondary winding feeds audio frequency voltage to the monitoring line К and Л to which the headphones of the control unit, the radio operator's post (ROP), the remote communication posts (RCP), as well as the output of the receiver are connected.

Anode voltage of +250 volts is supplied to valve 48 along wire 3 from rectifier B-2 via the primary winding of transformer 49. One end of the primary winding of transformer 49 is earthed for audio frequencies via capacitor 55.

2. Control Unit

The control unit circuit provides the following:

(a) switching on and off of the transmitter;

(b) selection of the mode of operation;

(c) adjustment of the transmitter power output;

(d) internal communication via the switchboard.

Switching the Transmitter On and Off

The heaters of the transmitter valves are energized by depressing the push-button START (ПУСК) at the control

unit, the radio operator's posts or the remote communication post (Fig.53). When this is done, +24 volts are applied via the normally closed contacts of switching-off relay 76, located in the control unit, along wire 115 to heater connecting contactor 550 in the rectifier assembly and to intermediate relay 90 located in the control unit. At the same time green signal lamp 98 of the control unit lights up, indicating that the heaters have been energized.

Auxiliary relay 90 operates and its contacts interconnect the wires 115 and 116, thus bypassing the push-button START (ПУСК). As a result, when the starting push-button is released, contactor 550 remains closed and signal lamp 98 continues to burn. When contactor 550 closes, voltage is applied to the primary windings of heater transformers 559, 521 and 538. In addition, when heater contactor 550 closes, heater voltage is supplied via its contacts from the additional secondary winding of transformer 561 of rectifier B-1, to valves 27, 91, 114, and 115 of the intermediate transmitter stages, to valve 300 of the second stage of the frequency-shift keying oscillator, to valves 2, 20, 21, 35, 36, 48, and 56 of the modulator and to valve $Л_{11}$ of the electronic stabilizer.

The heaters of the transmitter valves are deenergized by depressing the push-button STOP (СТОП) at the control unit, the radio operator's post, or the remote communication post. When this is done, 24 volts are applied to the winding of relay 76. Relay 76 operates, and its contacts break the supply circuit of heater contactor 550, relay 90, and signal lamp 98.

Contactor 550 removes voltage from the primary windings of heater transformers 559, 521 and 538, and also disconnects the additional winding of transformer 561. Heater voltage is removed from all the transmitter valves, and green signal lamp 98 goes out.

From 20 to 40 seconds after switching on of the heater voltage the high voltage can be switched on. This is done by setting toggle switch 96 RADIO-INTERCOM. (РАДИО-ВНУТР. ПЕРЕГОВОРЫ) of the control unit, the radio operator's post or the remote communication post in the position RADIO (РАДИО), (at the same time emergency switching-off toggle switch 508 of the BC-1 rectifier should be in the ON position). Relay 536 operates, switching on the rectifiers B-3 and B-4. Rectifier B-4 energizes bias relay 512, making the supply circuit of contactors 515 and 528 which switch on the rectifier B-2, B-5 and B-6. Given below is a description of the supply circuit of these relays and contactors.

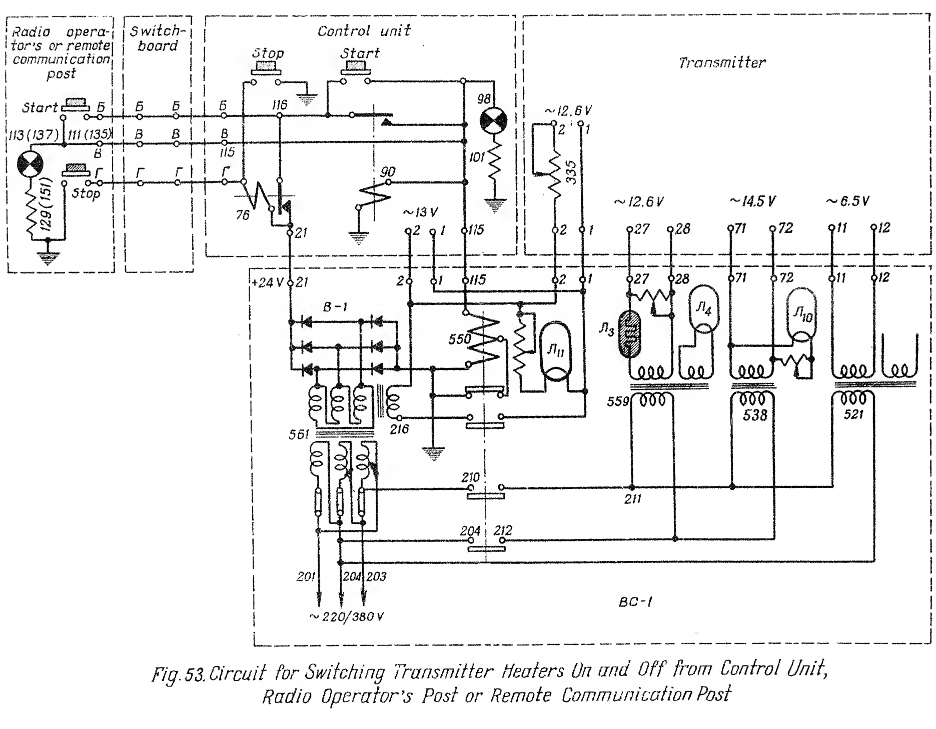

Fig. 53. Circuit for Switching Transmitter Heaters On and Off from Control Unit, Radio Operator's Post or Remote Communication Post

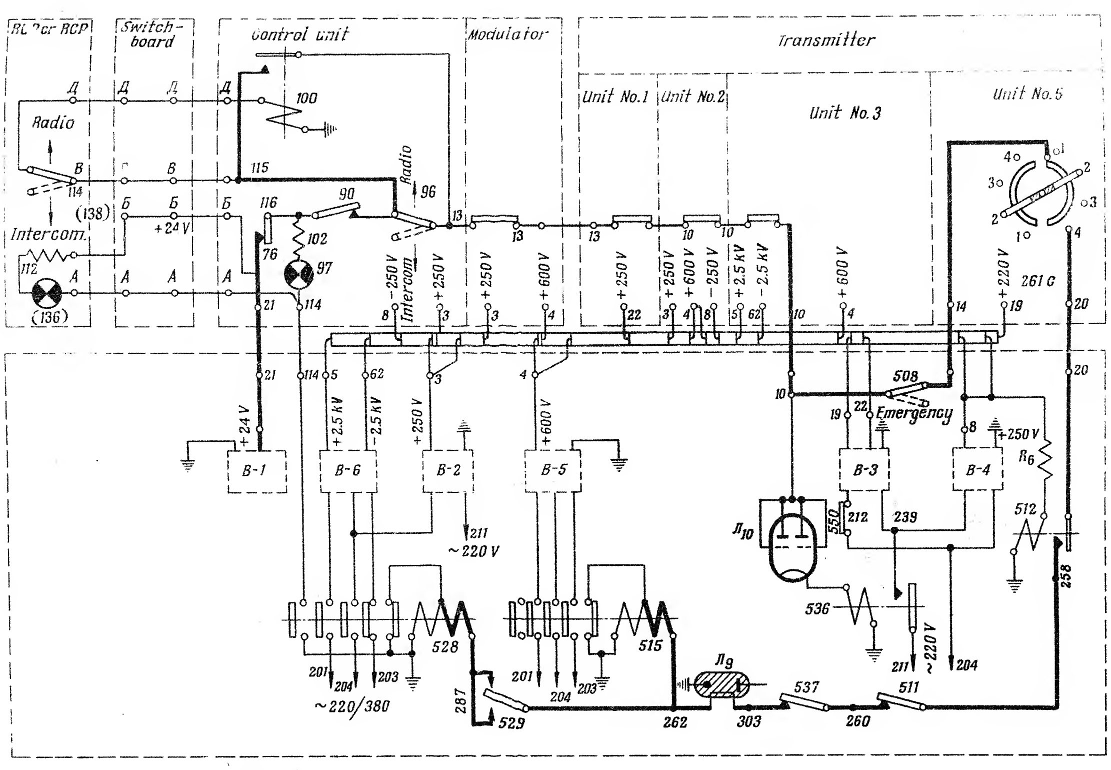

Fig.54. Circuit for Switching High Voltages on

Time relay 536 is supplied from rectifier B-1 via the following circuit: to the BC-1 rectifier from B-1 along wire 21, to the control unit along wire 21 via the closed contact of relay 76, along wire 116 via the closed contact of relay 90 (it had operated when the heaters were energized), along wire 115 via toggle switch 96 RADIO-INTERCOM., set in the position RADIO, along wire 13' via the closed interlock of the modulator, along wire 13 of the modulator to wire 13 of the transmitter via the terminal strip of the rectifier and from here to unit No.1. Having passed the interlock circuit of units Nos 1, 2 and 3, the +24 voltage is applied along wire 10 to the anode of valve Л$_{10}$ (time relay), to the winding of relay 536 and via the chassis to -24 volts. Relay 536 operates and via its closed contacts 211 and 239 mains voltage is supplied to rectifiors B-3 and B-4. Mains voltage is supplied to rectifier B-3 via the lamella of heater contactor 550, that is why rectifier B-3 cannot be switched on until contactor 550 operates.

After switching on rectifier B-4 grid bias relay 512, which is connected in parallel with the rectifier output, operates. The contacts of this relay make the circuit of contactors 515 and 528. The following is the supply circuit of the contactor windings: rectifier B-1, wire 10 in the rectifier assembly, closed emergency toggle switch 508 (in the second unit of the rectifier BC-1),

wire 14, function switch 261c (in unit No.5 of the transmitter) in positions 2, 3, 4, wire 20, the closed contacts of grid bias relay 512, the contacts of overload relay 511, the contacts of overload relay 537, the jumper inside protection gas discharge valve $Л_9$, the winding of contactor 515, the contacts of relay 529 TUNING-OPERATION (НАСТРОЙКА-РАБОТА) and the winding of contactor 528.

Contactors 515 and 528 supply mains voltage to rectifiers B-2, B-5 and B-6. When contactor 528 is on, red lamp 97 of the control unit lights up, indicating that high tension is on. Complete deenergizing of the transmitter, with the exception of the auxiliary-circuits rectifier B-1, which is required for operation of the automatic circuits, is achieved by depressing the push-button STOP (СТОП) of the control unit, the radio operator's post or the remote communication post. When this is done stopping relay 76 operates, deenergizing intermediate relay 90 which breaks the supply circuit of the time relay and contactors 515 and 528.

Selection of Mode of Operation

The transmitter provides the following modes of operation:

(1) C.W. keying (НЗТ);

(2) tone-modulation keying (ТОН);

(3) phone (ТЛФ);

(4) from external audio frequency source (ВНШ. МОД.).

The mode of operation is selected at the control unit with the aid of switch 77 (Fig.55).

Switch 77 has 6 wafers ganged on a common shaft.

The first wafer of switch 77 switches the screen-grids circuit of the fifth stage of the transmitter; the second switches the microphone supply circuit; the third switches the supply circuit of monitoring relay 64 and the supply circuit of keying relay 307; the fourth switches the supply circuits of modulator valves 20 and 21; the fifth switches the supply circuits of tone generator valve 36 and valve 2 of the first modulator stage; the sixth switches the supply circuit of the antenna relay.

C.W. keying is obtained with switch 77 in the first position. The key (Fig.56) is connected to the terminals КЛ and 21 of the control unit. When the key is depressed, +24 volts from terminal 21 of the control unit are fed via key 99 and the closed contacts of switch 96 RADIO-INTERCOM. (РАДИО-ВНУТР. ПЕРЕГОВОРЫ) (which is set in the position RADIO) to wire 18 of the control unit and from there along wire 18 to the transmitter. In the transmitter, the voltage is fed along wire 18 via function switch 261b, which is in the position CONTINUOUS RANGE (ПЛАВНЫЙ ДИАПАЗОН) or CRYSTAL (КВАРЦ), +24 volts are applied via series-connected

resistor 317 to keying relay 307. The relay operates, the armature is drawn to the working contact, and supply voltage is applied to the screen grid of master oscillator valve 1.

Note: If the transmitter is provided with an antenna relay, wire 18 is broken and its ends connected via the auxiliary normally-open contact of the antenna relay. Wire 18 located after the relay is designated 18^1.

Simultaneously +24 volts are fed from the transmitter via function switch 261b, along wire 24 to the control unit and from there via the third wafer of switch 77 along wire 107 to the modulator via resistor 63 to the winding of monitoring relay 64. Relay 64 operates, and the tone generator begins operating normally.

For the convenience of the attending personnel, the transmitter is provided with push-button 322 which duplicates the operation of the telegraph key. When button 322 is depressed, +24 volts are supplied along wire 24 to the winding of keying relay 307, bypassing switch 261b.

Semi-duplex operation is obtained by setting toggle switch 92 of the semi-duplex circuit in position ON (ВКЛ.). When switch 92 is ON (after the key is depressed), +24 volts are taken from wire 18 of the control unit via switch 92 and resistor 95 to the winding of semi-duplex relay 93.

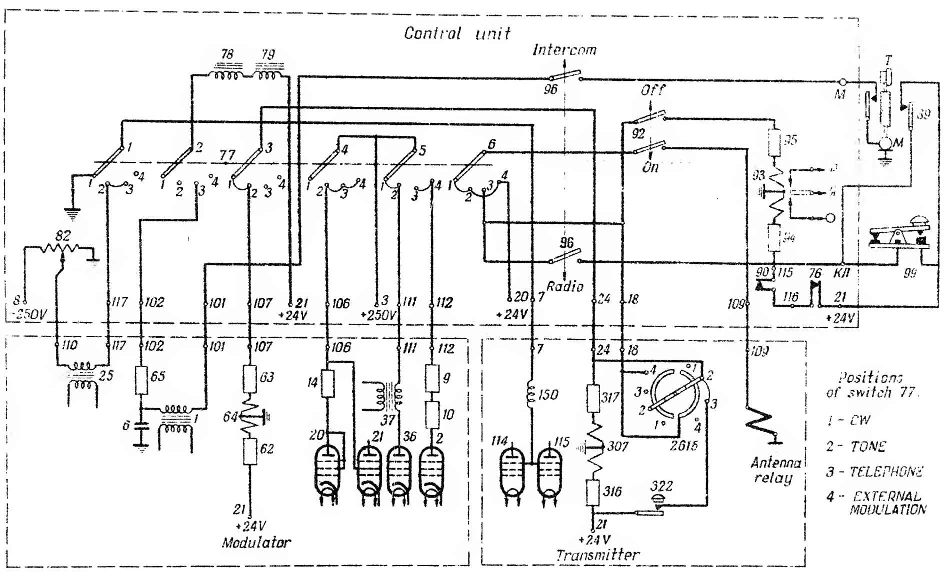

Fig.55. Function Switch Circuit

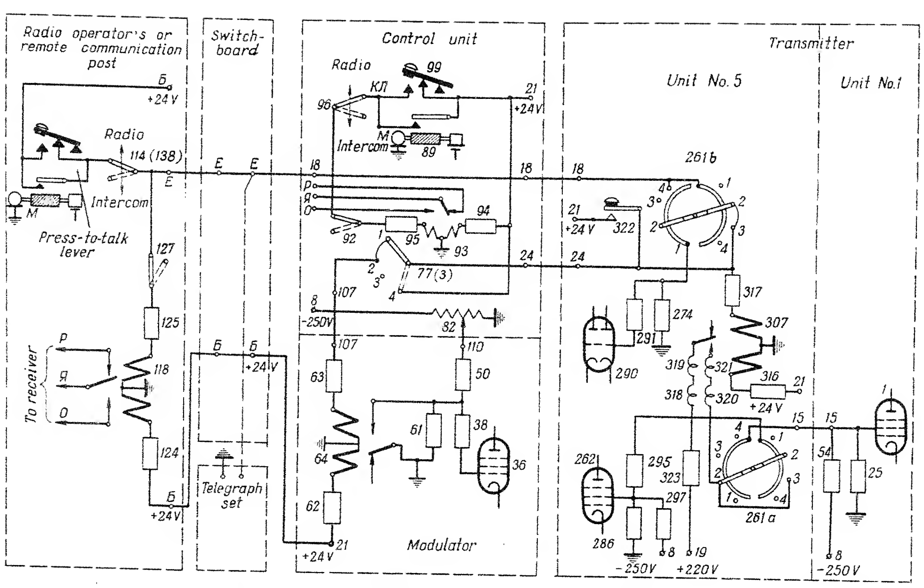

Fig.56. Circuit of Key and Telegraph Set Keying

The contacts of the semi-duplex relay are led out to the terminals of the control unit (P, Я and O) and can be used for cutting off the receiver when the key is depressed.

When function switch 77 is in position 1, its first wafer switches earth to the suppressor grids of the output stage of the transmitter. The second wafer is idle. The third wafer connects the winding of monitoring relay 64 in parallel with the winding of keying relay 307. The fourth wafer is idle. The fifth wafer supplies anode voltage to valve 36 of the tone generator (wires 3 and 111). Wafer 6 (Fig.57) is provided for supplying voltage to the antenna relay (if one is installed in the transmitter). With semi-duplex toggle switch 92 ON, voltage is supplied to the antenna relay: along wire 20 via the sixth wafer of switch 77, the closed contacts of toggle switch 92, wire 109 and from there to the winding of the auxiliary antenna relay.

When the semi-duplex toggle switch 92 is OFF, the antenna relay is supplied from wire 21, i.e. the antenna is connected to the transmitter output at the moment when mains voltage is supplied to the rectifier assembly. As the winding of the antenna relay draws about 6 amperes, it is controlled by an intermediate low power relay. The

antenna relay connects the antenna to the transmitter and simultaneously short-circuits the receiver input to earth. In addition wires 18 and 18^1 are interconnected by auxiliary contacts.

Tone-modulated keying is obtained with function switch 77 in the second position.

The telegraph key is connected in the same way as in the first position of the switch; the passage of current is identical to that described above.

Negative bias for the suppressor grids of valves 161 and 162 of the fifth transmitter stage (Fig.58) is supplied from potentiometer 82, located in the control unit, along wire 110 to the modulator and from there via the winding of output transformer 25 along wire 117 to the first wafer of function switch 77 and along wire 7 to the transmitter to the suppressor grids of the output stage valves.

Anode voltage of +250 volts is supplied to the modulator valves from terminal 3 of the rectifier assembly to the control unit and from there via the fourth and fifth wafers of function switch 77 to the modulator. Via the fourth wafer of switch 77, along wire 106, voltage is supplied to the screen grid of the second modulator stage valve (20), as well as to the screen grid of output valve 21 of the modulator. Via the fifth wafer along wire 111, anode and

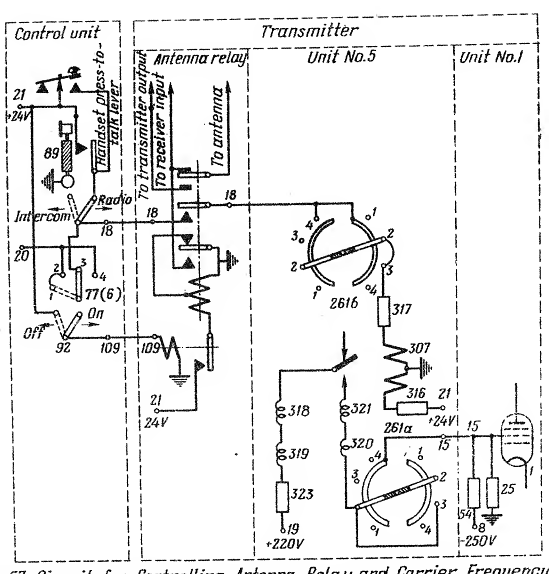

Fig.57. Circuit for Controlling Antenna Relay and Carrier Frequency in Telephone Semi-Duplex and Telegraph Operation

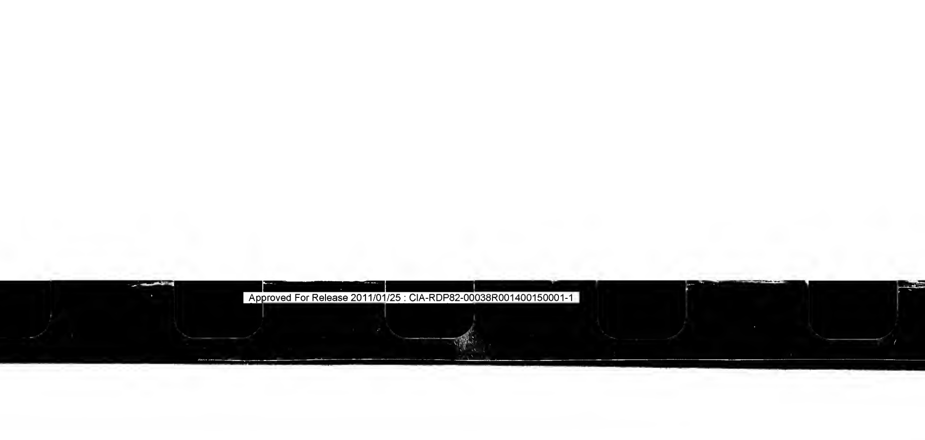

Fig. 58. Circuit for Telephone Operation of the Transmitter from the CU, ROP or RCP

screen grid voltage is fed to valve 36 of the tone generator.

In tone modulated keying, the tone generator is used as a source of signals for monitoring the operation of the transmitter and for supplying tone frequency voltage to the grid of the second modulator valve (20). The first valve (microphone amplifier) does not operate and is not supplied with anode voltage.

The antenna relay, which is switched by the sixth wafer of switch 77, is supplied in the same way as in CW keying operation.

Microphone operation is obtained with function switch 77 in the third position (Fig.58); the source can be the microphone of the handset of the control unit, the radio operator's post (ROP), or the remote communication post (RCP).

In telephone operation, as in tone-modulated operation, the transmitter is switched to telephone operation by applying negative bias from potentiometer 82 to the suppressor grids of valves 161 and 162 of the output stage. In addition to the negative bias, the suppressor grids are supplied with audio frequency voltage from the secondary winding of output modulation transformer 25. In telephone operation, the master oscillator is supplied with normal

D.C. voltage. This occurs when the press-to-talk lever of the handset is depressed.

When the press-to-talk lever is depressed, one pair of contacts connects the microphone of the handset to the supply source. The microphone is supplied by the circuit: +24 volts from wire 21 of the control unit via the chokes of smoothing two-stage filter 78 and 79, the second wafer of function switch 77, wire 102 and resistor 65 in the modulator, the primary winding of output transformer 1 of the modulator, wire 101 to the control unit and from there via the contacts of toggle switch 96 in position RADIO, via the contacts of the press-to-talk lever, the microphone and the chassis (-24 volts). Audio frequency current from the microphone flows via the closed contacts of the press-to-talk lever and toggle switch 96, wire 101, the primary winding of output transformer 1 and from there via capacitor 6 to the chassis.

Keying relay 307 is supplied from wire 21 of the control unit (Fig.56) via the closed contacts of the press-to-talk lever, toggle switch 96 in position RADIO, wire 18 of the control unit, wire 18 of the transmitter, function switch 261b and resistor 317. Simultaneously, +24 volts from wire 18 of the control unit (Fig.57) are applied via the sixth wafer of switch 77, with semi-duplex toggle switch 92 ON, along wire 109 to the winding

of the auxiliary antenna relay (if one is installed). Consequently, when semi-duplex toggle switch 92 is ON, the antenna is connected to the transmitter only when the press-to-talk lever is depressed.

Operation from an External Source of Audio Frequency (external modulation) is obtained with the function switch in the fourth position (Fig.58).

In this position the transmitter operates in the telephone mode and its radio frequency oscillations are modulated by tone signals from any source of external modulation.

Keying relay 307 is supplied with +24 volts not by the way of the telegraph key. Monitoring relay 64 in the modulator is disconnected along wire 107 by the third wafer of switch 77. A voltage of +24 volts is fed along wire 21 from the control unit via the third wafer of switch 77, along wire 24 to the transmitter (via the terminal strip of rectifier BC-1) and from there to the winding of keying relay 307. The armature of the relay is now drawn to the working contact and will be retained there regardless of whether the telegraph key or the press-to-talk lever are depressed or not.

Tone signals are sent along line X (Fig.58) to the control unit and from there along wire 101 to the modulator, to the primary winding of input transformer 1. The other

of the auxiliary antenna relay (if one is installed). Consequently, when semi-duplex toggle switch 92 is ON, the antenna is connected to the transmitter only when the press-to-talk lever is depressed.

Operation from an External Source of Audio Frequency (external modulation) is obtained with the function switch in the fourth position (Fig.58).

In this position the transmitter operates in the telephone mode and its radio frequency oscillations are modulated by tone signals from any source of external modulation.

Keying relay 307 is supplied with +24 volts not by the way of the telegraph key. Monitoring relay 64 in the modulator is disconnected along wire 107 by the third wafer of switch 77. A voltage of +24 volts is fed along wire 21 from the control unit via the third wafer of switch 77, along wire 24 to the transmitter (via the terminal strip of rectifier BC-1) and from there to the winding of keying relay 307. The armature of the relay is now drawn to the working contact and will be retained there regardless of whether the telegraph key or the press-to-talk lever are depressed or not.

Tone signals are sent along line M (Fig.58) to the control unit and from there along wire 101 to the modulator, to the primary winding of input transformer 1. The other

end of the primary winding of the transformer is bypassed for audio frequencies to earth by capacitor 6, while the circuit of the direct current flowing through wire 102 in the control unit, is insulated by the second wafer of switch 77 from earth and from other circuits.

In order to reduce the number of wires leading from the control unit to the switchboard of the remote communication posts (КВПС), microphone and external modulation signals are sent along wire Ж and wire О (earth).

Adjusting the Power Output of the Transmitter

The control unit houses switch 83 which has five positions (See Appendix 13). Knife switch 83 is connected via wire 6 to the screen grid circuit of the fourth stage valves (114 and 115), type П-50.

Depending on the position of switch 83, the suppressor grids of the valves are supplied with various bias voltages from potentiometer 82.

In the extreme clockwise position of switch 83, the suppressor grids are connected to earth, which corresponds to operation at full output (100%). When the switch is turned counter-clockwise, power is reduced approximately to 75, 50, 25 and 5 per cent of full output.

Internal Communication via the Switchboard and Monitoring the Operation of the Transmitter

Internal communication is provided by means of telephone handsets 89, 116, 139 (Fig.59). In order to conduct internal communication employing the control unit, radio operator's or remote communication posts toggle switches 96, 114, or 138 are set in the position INTERCOM.(ВНУТР. ПЕРЕГОВОРЫ). In this case the microphone is connected to line М leading to the switchboard of the remote posts along the circuit: microphone, closed contacts of the press-to-talk lever, wire М to the control unit, the radio operator's post or the remote communication post, toggle switches 96, 114 or 138 set in the position INTERCOM., the primary winding of transformer 88, 119 or 142, resistor 86, 123 or 146, the line М and on to the switchboard of the remote communication posts and radio operator's posts where 24 volts are supplied.

The switchboard calls the control unit, the radio operator's post or the remote communication post by sending a tone signal (from the tone generator of the switchboard) to the earphones of the handsets along lines К and Л, simultaneously sending voltage from the local battery of the independent supply source of the switchboard along line Н to signal lamps 85, 121 or 144.

The switchboard is called from the control unit, radio operator's post or remote communication post by pressing call button 84, 120 or 143. In this case 24 volts from the switchboard are fed along line M via the closed contacts of the call button and along line H to the call lamp of the switchboard.

Monitoring of the telegraph or telephone operation of the transmitter is conducted from the tone generator in telegraphy and the first modulator stage is telephony, via the monitoring stage in the modulator along wires K and Л to the headphones of the control unit and simultaneously to the switched-on telephones of the radio operator's posts or remote communication posts, via the switchboard.

3. Radio Operator's Post and Remote Communication Post

The radio operator's post (ROP) is installed directly at the receiver and serves for remote control of the transmitter. The remote communication post (RCP) is installed at a place removed from both the receiver and the transmitter; radio communication from this post is conducted directly by the captain of the ship or other persons entitled to it. The circuits of the radio operator's post and remote communication posts are shown in Appendix 13.

The radio station is controlled from the radio operator's post or remote communication post along twelve wires

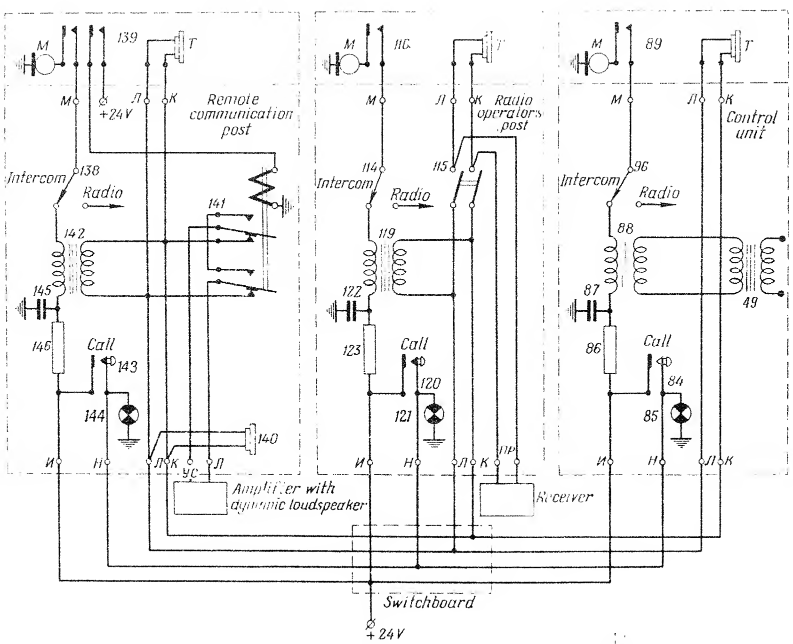

Fig.59. Internal Communication Circuit

via the switchboard. For this purpose the following connecting lines are provided:

А - high voltage signalling system (readiness of the transmitter for operation);

Б - supply of control circuits (+24 volts);

В - starting of the transmitter and start signalling system (switching on of heater supply);

Г - stopping of the transmitter (switching off of the supply);

Д - switching on of high voltage;

Е - keying with telegraph key or press-to-talk lever;

Ж - microphone operation via the transmitter;

И - microphone circuit in internal communication;

К and Л - monitoring of telegraph and telephone operation of transmitter, internal communication line, and audio frequency output of receiver;

З - return circuits of all lines (EARTH);

Н - call circuits and call signalling system.

In order to reduce interference from various circuits of the radio operator's post and remote communication post, the line Ж should be screened separately. For the same reasons it is also desirable to screen line К and Л (in one sheath).

Starting and stopping of the transmitter from the radio operator's post or the remote communication post is done in the same way as from the control unit. The heater supply is switched on by depressing push-button 111 START (ПУСК) of the remote operator's post or 135 of the remote communication post (Fig.53). After this button is depressed, +24 volts from the switchboard are supplied along line Б via the contacts of the START push-button, to line B and on through the switchboard to wire 115 in the control unit, to the winding of intermediate relay 90 and heater contactor 550 in the rectifier BC-1. Auxiliary relay 90 operates, and its contacts connect wires 115 and 116, thus shunting the START push-button. In this case line B, via the closed contacts of relay 90, will be supplied with +24 volts for green signal lamps 113 (137) HEATER (НАКАЛ) located at the radio operator's post or remote communication post which is switched on.

The heater supply of the transmitter valves is switched off from any remote communication post or radio operator's post (switched to the transmitter) by depressing the STOP push-buttons 111 of the radio operator's post or 135 of the remote communication post. In this case the supply circuit of stopping relay 76 from rectifier B-1 is made via the winding of relay 76 along line Г through the switchboard and via the closed contacts of the STOP push-button to the

chassis (common minus). Stopping relay 76 operates deenergizing wire 116, intermediate relay 90 and the winding of contactor 550 in the rectifier BC-1. Simultaneously relay 90 removes the +24 voltage from line B and the green signal lamps go out.

High voltage is switched on from the radio operator's post or the remote communication post by setting toggle switch RADIO-INTERCOM. 114 or 138 (Fig.54) in the position RADIO. In this case +24 volts from wire 115 are fed along line B through the switchboard to the radio operator's post or remote communication post along line Д to the winding of remote relay 100 located in the control unit. Relay 100 operates and its contacts connect wire 115' and wire 13'. With the interlocking contact and the contacts of time relay 536 closed, high voltage contactors 515 and 528 operate and all high voltages are applied to the transmitter. Via the auxiliary contacts of contactor 528 supply voltage is fed to red signal lamps 112 (136) HIGH VOLTAGE (ВЫС. НАПР.) along wires 114 and A.

When keying with the key or the press-to-talk lever at the radio operator's post or remote communication post (See Fig.56) +24 volts from line Б are supplied via the closed contacts of the key or lever and the closed contacts of toggle switch 114 or 138 in the position RADIO to line E. From there the +24 volts are fed to the switchboard, via

wire 18 of the control unit to the transmitter and via the closed contacts of function switch 261b (when it is set in position CRYSTAL or CONTINUOUS RANGE) to the winding of keying relay 307. The same +24 volts from line E to the radio operator's post are fed through resistor 125 to the winding of keying relay 118 of the receiver when semi-duplex toggle switch 127 is ON. Consequently, keying relay 307 of the transmitter and keying relay 118 of the receiver will operate simultaneously. No keying relay is provided for the receiver of the remote communication post.

Signals from the printing telegraph set are also sent along line E. In this case, the line E in the transmitter is switched over from keying relay 307 to input valve 290 (of the electronic relay), with the aid of switch 261b (position 4).

Microphone operation is conducted from the radio operator's post or the remote communication post with toggle switch RADIO-INTERCOM. 114 or 138 set in the position RADIO (Fig.58). In this case the microphone is connected to input transformer 1 of the modulator via the closed contacts of the press-to-talk lever, the closed contacts of the toggle switch 114 or 138, the wire Ж of the radio operator's post or the remote communication post, wire Ж of the switchboard, wire 101 of the control

unit to one end of the primary winding of the modulator transformer 1. The D.C. microphone supply circuit is the same as in telephone operation from the control unit. The line Ж also has provision for operation from a source of external modulation. In this case function switch 77 in the control unit should be set in the fourth position EXTERNAL MODULATION (ВНШ. МОД.).

The remote communication post is provided with relay 141 the contacts of which short-circuit the input of the amplifier supplied with the remote communication post when the handset press-to-talk lever is depressed. This precludes interaction between the dynamic loudspeaker and the microphone of the remote communication post. In addition, when relay 141 operates, the amplifier of the remote communication post is simultaneously disconnected from the monitoring line К and Л.

Relay 141 (See Appendix 13) is supplied by the following circuit: +24 volts from wire Б, the closed contacts of the handset press-to-talk lever, via the winding of relay 141 to the chassis. Relay 141 also operates when the key, connected to the remote communication post circuit via jack 147, is depressed.

4. Amplifier and Dynamic for the Remote Communication Post

In order to obtain loudspeaker reception in inter-communication and radio reception, the remote communication post is provided with an amplifier and dynamic loudspeaker (Fig.60).

The amplifier consists of two stages. The first stage employs a resistance-coupled circuit based on valve 222, type 6Ж8 . The output stage employs beam tetrode 231, type 30П1М , and output transformer 235, loaded by dynamic loudspeaker 249. The primary winding of input transformer 236 of the amplifier is supplied with audio frequency voltage via the closed contact of relay 141, located in the remote communication post and terminals 7 and 6. The secondary winding of transformer 236 is connected across the potentiometer 221 which serves for controlling the amplifier gain. Self-bias is provided for the control grid by the voltage drop across resistor 223 in the cathode circuit of valve 222. Screen grid voltage is supplied via dropping resistor 226.

The anode circuit of valve 222 includes resistor 228 from which audio frequency voltage is fed to the control grid of output valve 231, via blocking capacitor 230. Bias voltage for the control grid of valve 231 is produced by the voltage drop across resistor 233 in the cathode

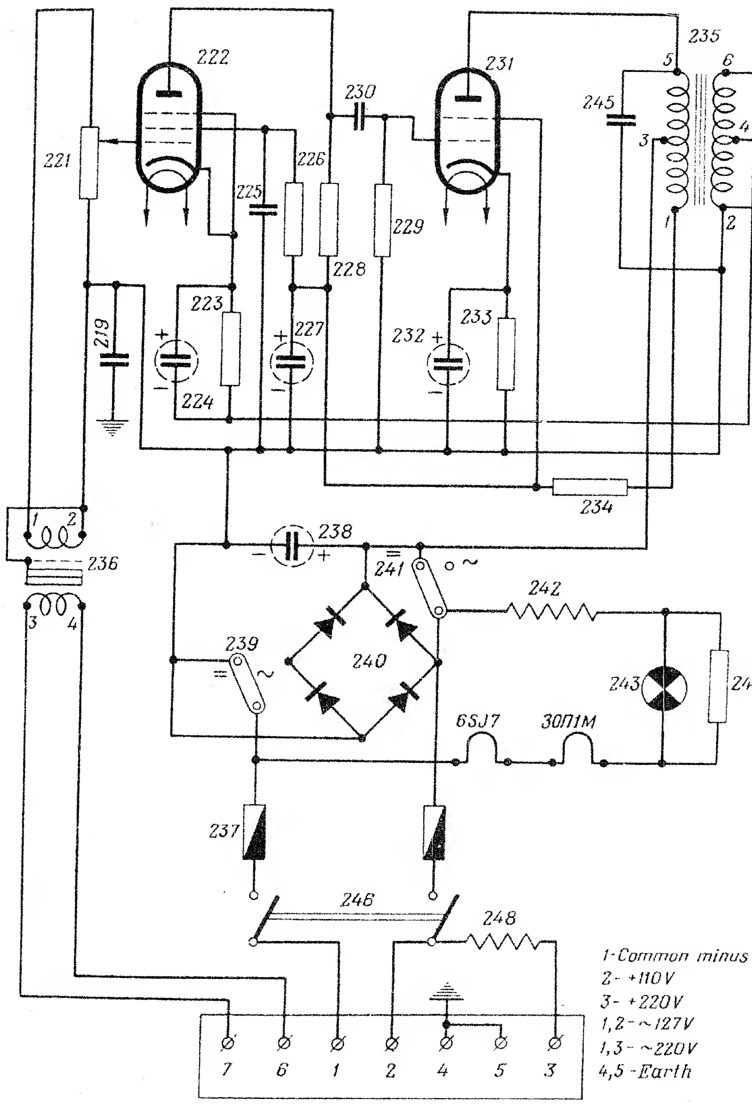

Fig. 60. Amplifier with Dynamic Loudspeaker for RGP

circuit. The primary winding of output transformer 235 bypassed by anti-parasitic capacitor 245 is connected to the anode circuit of valve 231.

In order to reduce harmonic distortions, both stages use negative feedback, the feedback voltage being removed from a section of the secondary winding of output transformer 235 and applied to the input of valve 222. With negative feedback, frequency and harmonic distortion of the amplifier as well as hum are reduced, and operation is more stable.

The amplifier is supplied directly from D.C. or A.C. mains of 110, 127 or 220 volts. When the amplifier is supplied from an A.C. mains, anode voltage is obtained from selenium rectifier 240 installed together with the amplifier and dynamic in one common case. The rectifier employs a bridge circuit. The rectified voltage is filtered with the aid of one-stage condenser-input filter formed by the part of the primary winding (points 3, 1) of output transformer 235, resistor 234 and electrolytic condensers 238 and 227. The output of this filter feeds the anode circuit of output valve 222 and the screen grid circuits of both amplifier valves. The anode circuit of output valve 231 is supplied via the second section of the primary winding (points 3, 5) of output transformer 235 and is connected

before the filter. As a result of such connection of the anode of valve 231 and a correct selection of the number of turns of the primary winding of transformer 235 and resistor 234, the hum voltage induced in the secondary winding by one part of the primary winding (points 3,5) is compensated by a similar voltage induced by the second part of the primary winding (points 3,1) which is 180° out of phase. In addition, such connection of the output stage practically reduces to zero the field current of the primary winding of transformer 235. When operating from a D.C. mains of 110 volts, anode voltage is supplied directly from the mains, bypassing the selenium rectifier, by re-setting jumpers 239 and 241. Attention should be paid in this case to the polarity of the mains.

In all supply versions, heater voltage is supplied to the valves directly from the mains via dropping resistors 242 and 244. Resistor 244 supplies voltage to lamp 243, which indicates that power has been switched on. When operating from a mains of 220 volts, excessive voltage is dropped by resistor 248. The D.C. circuit of the amplifier and dynamic is insulated from the chassis, while the audio frequency circuit is earthed via capacitor 219. This prevents earthing of the supply mains via the amplifier circuit.

5. Crystal Heating Element

The crystal heating element is designed for preliminary heating of the devices Б which contain the quartz crystals. The element is provided with three recesses into which the devices Б are inserted. Each recess is heated by a special winding. All three heating windings are connected in series and have a common temperature control circuit. Like the thermostat of the crystal-controlled oscillator, the crystal heating element is supplied directly from the primary supply mains and therefore is available in several supply circuit versions, intended for supply mains of various voltages.

Fig.61 shows the electrical circuit of the crystal heating element for a D.C. mains of 110 volts. Mains voltage is applied along wires 25 and 26, via toggle switch 168 and fuses 169, to the voltage divider consisting of resistors 164 and 165. A voltage of about 10-12 volts is supplied from resistor 165, via thermal regulator 161 to the winding of relay 160. Heating windings 157, 158 and 159 are fed with voltage via resistor 167, the contacts of relay 160 and three thermal fuses 156. The fuses are installed in each recess of the element and serve for breaking the heating winding circuit, should the temperature in the recesses exceed the permissible value. In parallel with resistor 167 is connected signal lamp 166 which lights up when current flows through the circuit of the heating windings.

In order to extinguish sparking which may occur during making and breaking of the contact of relay 160, a spark-extinguishing circuit consisting of resistor 171 and capacitor 170 is connected in parallel with the relay contacts. A spark-extinguishing circuit formed by resistor 163 and capacitor 162 is also connected in parallel with the contacts of the thermal regulator.

The electrical circuit of the crystal heating element is similar to that of the thermostats of units Nos 1 and 5 of the transmitter. The operating principle of the circuit is given in the description of unit No.1.

The electrical circuit of the crystal heating element for operation from a D.C. mains of 220 volts differs from the above circuit only in the value of resistor 164 (5,000 ohms instead of 2,500 ohms). The resistance of the heating windings is increased four times. This is obtained by connecting the halves of the windings in series, whereas for 110 volts they are connected in parallel.

When the transmitter is supplied with the mains the voltage of which fluctuates considerably from the nominal value (in submarines), the circuit of the crystal heating elements differs from the circuits described above for D.C. mains of 110 and 220 volts practically only in an increase in the heat dissipating power permissible for resistors 164 and 165.

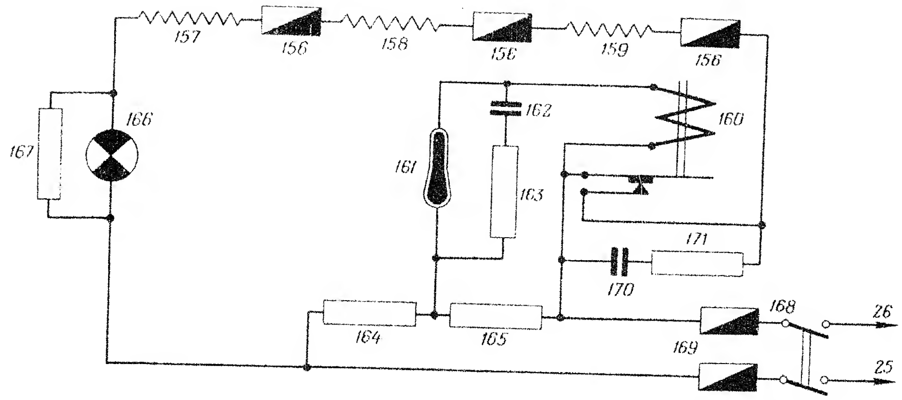

Fig.61. Circuit Diagram of Crystal Heating Element for Direct Current Mains

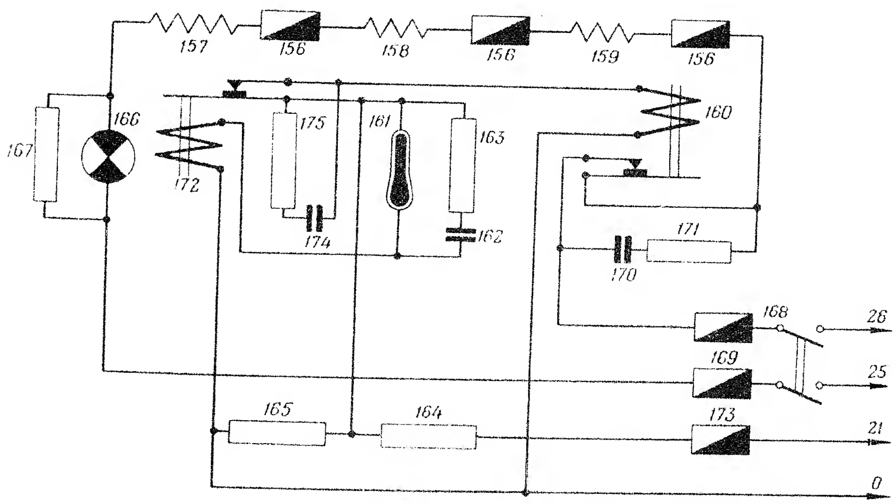

Fig.62. Circuit Diagram of Crystal Heating Element for A.C. Mains 220 V

The electrical circuit of the crystal heating element for a primary A.C. supply mains of 220 volts is shown in Fig.62. Mains voltage is supplied to heating windings 157, 158 and 159 along wires 25, 26 via toggle switch 168, fuses 169, resistor 167 with signal lamp 166 connected in parallel, the contacts of relay 160 and three thermal fuses 156.

The control circuit consists of thermal regulator 161 and the winding of relay 172 and is supplied by the voltage divider consisting of resistors 165 and 164. Along wires 21 and 0 via fuse 173, the divider is supplied with 24 volts D.C. from the rectifier B-1 of the radio station, which for this reason must be switched on for the thermostat to operate. The winding of relay 160 is fed by the same voltage divider via the contacts of relay 172. In parallel with the contacts of relay 172 is connected a spark-extinguishing circuit consisting of resistor 175 and capacitor 174; in parallel with the contacts of relay 160 - a spark-extinguishing circuit consisting of resistor 171 and capacitor 170, and in parallel with the contacts of the thermal regulator - a spark-extinguishing circuit consisting of resistor 163 and capacitor 162.

The electrical circuit of the crystal heating element for A.C. mains of 220 volts is similar to the circuit of the thermostat of units Nos 1 and 5 of the transmitter for A.C. mains.

Chapter IV

OPERATING INSTRUCTIONS AND MAINTENANCE OF THE KB-1 TRANSMITTING RADIO STATION

A. OPERATING THE RADIO STATION

1. Preparation for Tuning

When preparing the station use the following procedure:

(1) From 2.5 to 3 hours prior to operation, switch on the heating of the oscillator thermostat by means of the thermostat heating toggle switch located on the front panel of unit No.1 of the transmitter; this time is sufficient for all the tuned circuit components of the first stage, which determine the transmitter frequency to reach the temperature at which the oscillator was calibrated at the factory. If the thermostat heater operates normally, the signal lamp on the front panel of unit No.1 should go on and out periodically. At the same time the characteristic noise of the thermostat fan motor should be heard. If for some reason or other the thermostat cannot be switched on, then the frequency setting accuracy of the operating station will be below that guaranteed by the factory.

(2) For operation on crystal-controlled frequencies, the heater of the thermostat of unit No.5 and the preliminary crystal heating element, should be switched on from 2 to 3 hours before operation, with the devices Б which are to be used, inserted beforehand into the thermostats. If the ambient temperature is not lower than $+20^{0}$, a preliminary heating period of 1 to 1.5 hours is sufficient. With the thermostat heating switched off, the frequency accuracy of devices Б is reduced.

(3) When the station is supplied by a D.C. mains, the next stage in the preparation of the radio station for operation should be the starting of the converter.

For this proceed as follows:

(a) set the knob for emergency starting of the motor at the starting station in the position STOP (СТОП);

(b) set the knob of the manual excitation control PB or P3B in the extreme position for maximum resistance LESS (НИЖЕ);

(c) set the mains switch of the rectifier assembly in the middle position OFF (ВЫКЛЮЧЕНО);

(d) on the supply switchboard, set the ship's mains switch in one of the positions STARBOARD (ПРАВЫЙ БОРТ) or PORT (ЛЕВЫЙ БОРТ); if voltage is available, one of the signal lamps should light up and the voltmeter should read the voltage of the D.C. mains;

(e) depress the push-button START (ПУСК) on the supply switchboard and keep it depressed for 1-2 seconds, if for some reason or other automatic starting does not occur, then the converter can be started by hand until the cause of the fault is discovered. For this the emergency starting knob should be switched from the position STOP to the position START, pausing at each contact for 2-3 seconds.

When starting the converter, the A.C. generator should become excited. When the voltage stabilizers БРКТ, БРШТ and РУН are used, the voltage of the generator should automatically set to near the nominal value, i.e. 220 volts. In the case of the ПНТ-85 generators (converter П-7.2) which are not provided with full automatic stabilization, the voltage is set with the manual regulator РЗВ , according to the voltmeter located in the rectifier assembly.

The voltage generator of converter ПТ-5 , in case of failure of the automatic carbon voltage regulators РУН to operate, is regulated in the following way. The rotary switch of the regulator РВ is turned to the position at which the resistance of the carbon stack is shunted. After the switch is set, the knob of the РВ regulator is turned to set the required generator voltage, using the voltmeter located on the rectifier assembly.

Regardless of the value of the external load, no further adjustment of the generator voltage will be necessary, when the current stabilizer is operating.

The speed of the converter motor should not be adjusted during service.

During operation of the converter, it is necessary to monitor the value of the current consumed from the mains by means of the ammeter mounted on the supply switchboard (the ammeter, installed in unit No.1 of the rectifier assembly, monitors the current supplied by the generator).

(4) Turn the supply knife switch of the rectifier to the position PORT or STARBOARD, depending on where the A.C. voltage of the converter of the ship's A.C. mains is fed to. If there is voltage in the mains, the neon signal lamps located under the knife switch will light up.

(5) Check the value of the mains voltage with the voltmeter in unit No.1 of the rectifier (198-242 volts are normal for a 220-volt mains and 342-418 for a 380-volt mains. With the same voltmeter check the +24 voltage of the auxiliary circuit (24 to 30 volts are normal); should the voltage be less, check the fuses ПР-5 and ПР-4 in the first rectifier unit.

Note: The ship's mains knife switch of the rectifier may be switched off only during prolonged interruptions in the operation of the trans-

mitter. This is found necessary due to the fact that with the knife switched off the +24 volt circuit supplying the automatic system is broken and consequently remote switching on of the station from the control unit, the remote communication post of the radio operator's post becomes impossible.

(6) Set the switch of the series-connected capacitors of the antenna circuit of unit No.4 of the transmitter in position 5 (earth). The antenna is now earthed and in this way inadvertent transmission during preparation of the station for operation is precluded.

(7) From 5 to 10 minutes prior to transmission, switch on the heaters of the transmitter valves with the aid of the push-button START (ПУСК) of the control unit, the green lamp of the control unit should now light up. Preliminary switching on of the heater supply is necessary in order to increase the frequency setting accuracy.

(8) Set the high voltage toggle switch of unit No.1 of the rectifier in the position TUNING (НАСТРОЙКА), the blue signal lamp of unit No.3 of the rectifier should light up.

(9) Use the toggle switch RADIO-INTERCOM. of the control unit to switch on high voltage; the toggle switch being in the upper position RADIO. The emergency switch of the second rectifier unit should be in position ON (ВКЛ.). The

emergency switch should only be used if it is necessary to switch off high voltage urgently or when it is necessary to preclude switching on of high voltage by the remote posts. If the emergency switch is left in the off position unintentionally, this may cause an interruption in communication.

If high voltage is switched on immediately after switching on the heater voltage, it will be automatically delayed for 20 to 40 seconds. This is the time of operation of the valve time relay.

(10) On being convinced that the rectifier functions normally, switch off high voltage by setting the toggle switch RADIO-INTERCOM. in the position INTERCOM. The red lamp of the control unit will go out. This operation completes the preparation of the transmitter for tuning.

(11) For complete switching off of the station, it is necessary to depress the push-button STOP of the control unit. The transmitter valve heaters will now be switched off, and the green signal lamp of the control unit will go out.

(12) The converter is stopped in the following way:

(a) in the case of manual regulation, remove the generator voltage by setting the knobs of the regulators PB or P3B in the position LESS (НИЖЕ);

(b) by pressing the push-button STOP on the supply switchboard (when the automatic system is in

operation) stop the electric motor. If the electric motor was started with the manual emergency switch, then the knob of this switch should be turned rapidly from the position START to the position STOP and the STOP push-button on the supply switchboard pressed again.

(c) the ship's mains switch on the supply switchboard is set in the middle position. The signal lamp will now go out.

After stopping the motor, the ship's mains switch should be switched off.

2. Tuning the Transmitter in the Continuous Range without Tables

Preparation of Tuning Tables

The papers supplied with the station include a calibration book. This book is not filled in completely at the factory, as the transmitter is checked at the factory not with an antenna but with a dummy antenna which is a wire-wound resistor of 70 ohms.

The tuning of the antenna circuit, the value of the coupling to the antenna, and the tuning of the output stage depend on the type and characteristic of the antenna

into which the transmitter will operate at the place of installation. For this reason the corresponding columns of the tuning tables in the book are not filled in at the factory. This work must be carried out after checking the power unit, the oscillator and the intermediate stages of the transmitter.

To do this proceed as follows:

(a) start the converter and make sure there is mains voltage;

(b) switch on the power switch of the rectifier;

(c) switch on the valve heaters using the push-button of the control unit;

(d) set the first band with the band selector switch;

(e) set the antenna coupling knob in position 1;

(f) set the given frequency (3 Mc/s) according to the optical tuning dial;

(g) set the function switch of unit No.5 in the position CONTINUOUS RANGE (ПЛАВНЫЙ ДИАПАЗОН);

(h) set the high voltage toggle switch in the position TUNING (НАСТРОЙКА); set the function switch of the control unit in the position CW (НЗТ), switch on high voltage and depress the key;

(i) operate the tuning knobs of the third-fifth stages, to tune the circuits to maximum current in the

control grid circuit of the fifth stage; the reading of the third-fifth stages dial should correspond to that indicated in the calibration book (small divergence within 1-2 divisions is permissible);

(j) use the tuning knob of the fifth stage to tune the intermediate circuit to minimum anode current of the fifth stage valve;

(k) increase antenna coupling by several positions and tune the antenna circuit to maximum reading of the antenna indicator or maximum reading of the anode milliammeter of the fifth stage valve. If the antenna circuit does not tune at once, try various combinations of settings of the knobs of the series- and parallel-connected capacitors of the antenna circuit;

(l) after tuning the antenna circuit, adjust the antenna coupling in such a way that the anode current of the fifth stage attains a value of approximately 0.4-0.5 ampere and a slight detuning of the antenna circuit to right and left of the resonance position causes the anode current of the fifth stage to decrease;

(m) switch off high voltage with the toggle switch of the control unit; set the high voltage toggle switch on the rectifier in the position OPERATION (РАБОТА) and switch high voltage on again;

(n) depress the key, check how accurately the antenna circuit and the intermediate circuit are tuned;

(o) by adjusting the coupling bring the anode current of the fifth stage valves to the normal value of about 0.6 to 0.8 ampere (the pointer of the meter should not go beyond the limits of the coloured sector).

The grid current of the fifth stage valves should be within 10-30 mA. The operating conditions of the first, second, third and fourth stages should correspond to the table of operating conditions compiled by the factory. Deviations within 20-25 per cent are permissible.

The heating of the ГУ-80 valve anodes should not exceed the permissible value (permissible heating is characterized by a cherry red colour of the middle section of the anode).

If the above conditions are fulfilled, the positions of the tuning knobs and dial divisions are entered in the tables of the calibration book, and the next higher frequency can be tuned to. In this way all the tables of the calibration book are filled in.

Tuning the Antenna Circuit when Operating into Various Types of Antennas

As was already mentioned above, the positions of the antenna circuit knobs when tuning to a given frequency have

to be found experimentally. It is possible that several combinations of knob positions may be found at which the antenna circuit tunes. The combination chosen should provide for the following:

(a) the series-connected capacity is short-circuited or of maximum value;

(b) the parallel-connected capacity is disconnected or at minimum value;

(c) tuning to resonance is sharpest;

(d) the continuous tuning knob of the antenna circuit is not at the end or beginning of the dial, i.e. it is possible to tune to left and right of resonance;

(e) the anode current load of the ГУ-80 valves is greatest, while anode heating is the least.

With series feed of the antenna (series connection of the condensers) the reading of the antenna meter (indicator) is proportional to the current in the antenna proper and in this case it is necessary to tune to maximum reading of the indicator. With parallel antenna feed (parallel connections of the condensers) the reading of the antenna indicator is proportional to the current in the antenna circuit.

The looser the coupling of the antenna to the antenna circuit the greater the current and the more power lost in

the antenna circuit proper and less fed into the antenna. For this reason, when tuning the antenna circuit to maximum reading of the antenna indicator with parallel antenna feed, it is necessary to try to obtain a lesser value of this maximum reading by decreasing the capacitance connected in parallel with the antenna.

When tuning the antenna circuit, proceed as follows:

(a) decrease anode voltage of the fifth stage (position TUNING) when tuning;

(b) tune the fifth stage with antenna coupling at the minimum value;

(c) without changing the tuning of the fifth stage circuit increase the antenna coupling by turning the knob ANTENNA COUPLING (СВЯЗЬ С АНТЕННОЙ) one or two positions to the right;

(d) it is recommended to begin tuning the antenna circuit from the position when one inductance is connected in the antenna circuit (the left-hand switch of the antenna circuit is in position 4, the right-hand switch in position 1). Switch on series capacitors beginning with the highest (positions 3, 2, 1), then as the need arises connect the parallel capacitances beginning with the lowest (position 2, and then 3, 4, etc.);

(e) having tuned the antenna circuit to the maximum reading of the indicator (or to maximum glowing of the neon lamp) and to maximum reading of the anode current meter of the fifth stage, increase the antenna coupling still more till the load of the fifth stage valves reaches a current of about 0.4-0.5 A (with reduced anode voltage).

Coupling should be increased gradually with simultaneous tuning of the antenna circuit. If the tuning is correct, detuning of the antenna circuit unloads the output stage. Decreasing coupling unloads the output stage, without greatly detuning it.

3. Tuning the Transmitter in the Continuous Range according to Tables

After preparation of the station, the transmitter is tuned according to the tables of the calibration book in the following way:

(a) Set the band selector switch to the required band.

WARNING. Switch over bands with the high voltage off.

(b) Set the given frequency on the optical dial with the knob TUNING OF 1st-2nd STAGES (НАСТРОЙКА I-II К).

(c) Set the function switch of transmitter unit No.5 in the position CONTINUOUS RANGE (ПЛАВНЫЙ ДИАПАЗОН).

(d) Set the high voltage switch of rectifier unit No.1 in the position TUNING (НАСТРОЙКА).

(e) According to the calibration table set the following transmitter tuning knobs: TUNING OF 3rd-5th STAGES (НАСТРОЙКА III-VK) of unit No.2; TUNING OF 5th STAGE (ПОДСТРОЙКА V КАСК.) of unit No.3; ANTENNA COUPLING (СВЯЗЬ С АНТЕННОЙ) of unit No.3; ANTENNA CIRCUIT INDUCTANCE (ИНДУКТИВНОСТЬ АНТЕННОГО КОНТУРА) of unit No.4; SERIES (ПОСЛ.) and PARALLEL (ПАРАЛЛ.) of the antenna circuit switches of unit No.4.

(f) Make sure that the appropriate antenna is connected to the transmitter via the transmitting-antennas switchboard.

(g) Switch on high voltage by setting the toggle switch of the control unit in the position RADIO (РАДИО).

(h) Depress the key or the push-button KEY (КЛЮЧ) of unit No.5 and tune the antenna circuit to maximum reading of the antenna indicator.

(i) Switch off high voltage; set the high voltage switch of unit No.1 in the position OPERATION (РАБОТА) and switch high voltage on again. This concludes preparation for operation.

4. Tuning the Transmitter with the Crystal-Controlled Oscillator

With the crystal-controlled oscillator, the transmitter should be tuned in the following way:

(a) Select the device Б according to the given frequency and insert it in unit No.5.

(b) Set the function switch of transmitter unit No.5 in the position CRYSTAL WAVES - AMPLITUDE KEYING (КВАРЦ. ВОЛНЫ - АМПЛ. МАНИП.) for amplitude keying or the position CRYSTAL WAVES-FREQUENCY-SHIFT KEYING (КВАРЦ. ВОЛНЫ - ЧАСТ. МАНИП.) for printing telegraphy.

(c) Set the band selector switch in accordance with the given frequency.

(d) Set the toggle switch of the rectifier unit No.1 in the position TUNING (НАСТРОЙКА).

(e) Switch on high tension from the control unit by setting the toggle switch RADIO-INTERCOM. in the position RADIO.

(f) Use the tuning knob of transmitter unit No.1 to tune the second transmitter stage coarsely by setting the given frequency on the optical dial. The second stage is tuned finally according to minimal anode current as measured by an external

milliammeter connected to the jack ANODE 2nd STAGE (АНОД II к) of transmitter unit No.1. Often tuning by the dial does not coincide with tuning by the milliammeter. This is due to the fact that the dial is calibrated by the frequency generated by the first stage, and absolutely exact tracking of the second and first stages is not always obtained.

(g) Switch off high tension by setting the toggle switch RADIO-INTERCOM. in the position INTERCOM.

(h) According to the tables of the calibration book, set all the tuning knobs of the 3rd-5th stages and the antenna circuit.

(i) Set the toggle switch of rectifier unit No.1 in the position OPERATION.

(j) Switch on high tension by setting the toggle switch of the control unit in the position RADIO.

(k) Tune the antenna circuit to maximum reading of the indicator.

5. Switching Modes of Operation

For CW telegraphy proceed as follows:

(a) tune the transmitter to the given frequency;

(b) set the function switch of the control unit in the position CW (НЗТ);

(c) depending on the communication conditions (distance, time, season, etc.) set the power regulator of the control unit in the required position;

(d) switch on high tension with the toggle switch RADIO-INTERCOM.

The operation of the transmitter can be monitored with the aid of the receiver headphones connected to the control unit, or with the handset of the control unit. Volume is adjusted with the monitoring volume control knob of the modulator unit in the control unit.

For tone-modulated telegraphy it is necessary to tune the transmitter in the same way as for CW telegraphy and to set the function switch of the control unit in the position TONE (ТОН).

For telephone operation proceed as follows:

(a) set the function switch of the control unit in the position TELEPHONE (ТЛФ.);

(b) set the power regulator in the position 5 corresponding to 100 per cent output (in telephone operation power must not be decreased otherwise considerable distortion due to overmodulation may be developed);

(c) switch on high tension with the toggle switch RADIO-INTERCOM. by setting it in the position RADIO;

(d) lift the handset, press the press-to-talk lever and transmit by microphone, listen to the answer of the other station when the press-to-talk lever is released.

The presence of modulation can be monitored by the modulation meter of the control unit. In order to avoid distortion caused by over-modulation care should be taken that the depth of modulation during transmission does not exceed 100 per cent, for which purpose the knob DEPTH OF MODULATION (ГЛУБИНА МОДУЛЯЦИИ) of the control unit is set in the appropriate position.

For external modulation it is necessary to connect the source of external modulation voltage to the lines Ж and О of the transmitter.

The transmitter should be tuned in the same way as for CW operation.

Set the function switch of the control unit in the position EXTERNAL MOD. (ВНШ. МОД.).

6. Operation from Remote Posts

For operation from the remote communication posts use the following procedure:

(a) set the toggle switch RADIO-INTERCOM. in the position INTERCOM., then lift the handset and press

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the push-button CALL (ВЫЗОВ). The call signal lamp of the switchboard should now light up;

(b) on hearing the response of the switchboard, request the party to be called, and hang up the handset again;

(c) on being told by the switchboard attendant that the equipment is ready, press the push-button START (ПУСК). After this the green lamp should light up, signalling that the heaters of the transmitter valves are switched on;

(d) set the toggle switch RADIO-INTERCOM. in the position RADIO. From 30 to 40 seconds after the heaters have been switched on, the red lamp will light up, signalling that high tension has been applied to the transmitter valves;

(e) after high tension has been applied to the transmitter, begin transmitting. Telegraph communication is conducted by means of the key. For telephone operation lift the handset, press the press-to-talk lever and speak into the microphone. For reception release the press-to-talk lever and listen to the answer of the party being called;

(f) under conditions of poor audibility or in case of loudspeaker reception, switch on the amplifier by setting the toggle switch in the position ON (ВКЛ.)

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Volume is controlled with the knob on the front panel of the amplifier;

(g) having completed communications, hang up the handset (in telephone operation). Switch off high tension by setting the toggle switch in the position INTERCOM. The red signal lamp should now go out. Switch off the amplifier. Depress the push-button STOP (СТОП), after which the green signal lamp should go out.

For operation from the radio operator's post use the following procedure:

(a) set the toggle switch in the position INTERCOM.; set the monitoring toggle switch in the position ON (ВКЛ.);

(b) lift the handset and press the CALL push-button; on hearing the response of the switchboard or transmitter, report that you are ready to transmit and hang up the handset;

(c) if the radio operator's post is switched to the transmitter which is ready for operation, then in order to transmit, switch on the heaters of the transmitter valves with the push-button START; the green signal lamp should now light up;

(d) set the toggle switch RADIO-INTERCOM. in the position RADIO. The red lamp should now light up

signalling that the high tension of the transmitter has been switched on;

(e) telegraph communication is conducted by means of the key. For telephone operation lift the handset, press the press-to-talk lever and speak into the microphone. Having spoken release the press-to-talk lever and wait for the answer. During lengthy reception, set the monitoring toggle switch in the position OFF (ВКЛ.);

(f) having completed operation, hang up the handset (in telephone operation) and switch off the high tension of the transmitter by setting the toggle switch RADIO-INTERCOM. in the position INTERCOM. The red signal lamp should now go out;

(g) switch off the heaters of the transmitter valves with the push-button STOP (СТОП), after which the green signal lamp should go out and the transmitter be switched off.

F o r i n t e r n a l c o m m u n i c a t i o n f r o m t h e r e m o t e p o s t s (r e m o t e c o m m u n i c a t i o n p o s t a n d r a d i o o p e r a t o r ' s p o s t) p r o c e e d a s f o l l o w s :

(a) set the toggle switch in the position INTERCOM. When operating from the radio operator's post it

is also necessary to set the monitoring switch in the position ON;

(b) lift the handset and press the CALL push-button. The white CALL signal lamp of the switchboard should now light up. The switchboard attendant should connect and call the required subscriber;

(c) if a call comes through to the radio operator's post or the remote communication post (the CALL lamp lights up or the call signal is heard in the telephone or in the dynamic loudspeaker of the remote communication post amplifier, if it is switched on), switch on the toggle switch INTERCOM., and in addition at the radio operator's post set the monitoring toggle switch in the position ON. Then lift the handset and answer the call;

(d) on completing communication hang up the handset. Switch off the monitoring toggle switch at the radio operator's post.

7. Semi-Duplex Operation

Semi-Duplex Operation with Two Antennas

This operation requires two antennas: receiving and transmitting antennas. For this purpose the receiver at the control unit or the radio operator's post should be

connected to the terminals P, H, O, according to the circuit of the receiver (depending on the receiver circuits which are affected by the contacts of the semi-duplex relay when the receiver is being cut off).

For reception on the transmitter frequency or near to it, set the semi-duplex toggle switch of the control unit and the radio operator's post in the position ON. Reception is conducted with the key released, because with the key depressed, the receiver is cut off. In telephone operation, reception is conducted with the press-to-talk lever released. With the handset lever depressed, the receiver is cut off and supply voltage is applied to the microphone of the handset.

In reception and transmission on different frequencies, or during prolonged reception, the semi-duplex toggle switch is set in the position OFF. Reception can be conducted simultaneously with transmission.

Semi-Duplex Operation with One Antenna

In this case the transmitter and the receiver operate into one antenna, switched by a special antenna relay, installed at the transmitter. The antenna terminal of the receiver is connected to the antenna relay by a radio-frequency cable.

In one-way communication (transmission without reception), the semi-duplex toggle switch of the control unit is set in the position OFF. In this case the antenna is connected to the transmitter as soon as mains voltage is applied.

In two-way telegraph communication, set the semi-duplex toggle switch of the control unit in the position ON. For reception, the toggle switch RADIO-INTERCOM. of the control unit or the radio operator's post is set in the position INTERCOM. and the antenna is connected to the receiver. For transmission, set the toggle switch in the position RADIO. High tension is applied to the transmitter and the antenna is connected to the transmitter.

For two-way telephone communication, set the semi-duplex toggle switch of the control unit in the position ON. For transmission press the press-to-talk lever which connects the antenna to the transmitter. On concluding transmission, release the press-to-talk lever; the antenna will now be connected to the receiver, making reception possible.

8. Printing by Radio

Printing by radio is carried out with the aid of telegraph sets.

To do this proceed as follows:

(a) connect the output of the telegraph set to the radio station, as indicated below;

(b) select the device Б corresponding to the given working frequency and insert it into the recess of transmitter unit No.5;

(c) tune the transmitter according to the tuning rules for operation with a crystal oscillator;

(d) set the function switch of transmitter unit No.5 in the position FREQUENCY-SHIFT KEYING OSCILLATOR (ВЧМ);

(e) set the function switch of the control unit in the position CW;

(f) switch on high tension, after which the transmitter is ready for operation from the telegraph set.

9. Checking Transmitter Frequency

The checking system is based on a comparison of the frequency of the oscillator with that of a heterodyne wavemeter by the zero beat method. For this purpose the function switch is provided with the position CHECKING (КОНТРОЛЬ). In this case the oscillator is supplied with the necessary voltages, while high tension is removed from the power stages. The oscillator is provided with a special R.F. output from which R.F. voltage is fed by cable to a heterodyne wavemeter.

The heterodyne wavemeter can be installed in another room, in which case the R.F. cable from the transmitter is led to the switchboard, via which the necessary connections are made. Zero beats can be heard in headphones plugged into the jack on the transmitter proper and connected via the switchboard to the output of the heterodyne wavemeter. This method allows the oscillator frequency to be checked even during operation of the transmitter.

The tuned circuit of the master oscillator is provided with trimming capacitors which allow the calibration of the oscillator to be corrected using the above described system of frequency checking.

In addition, the following operations can be carried out:

(a) setting of the working frequency of the transmitter before operation, according to the heterodyne wavemeter for obtaining searchless communication (especially at the short-wave part of the range);

(b) checking the transmitter frequency against a standard signal; in which case an auxiliary receiver is necessary. Frequency is compared by the zero beats at the receiver output;

(c) checking frequency of receivers against the transmitter oscillator.

Setting of Knobs for Checking Transmitter Frequency

(a) set the function switch of unit No.5 in the position CHECKING (КОНТРОЛЬ);

(b) the output of the heterodyne wavemeter which has previously been tuned to the frequency to be checked, is switched to the transmitter;

(c) insert the headphones plug into the jack marked FREQUENCY CHECKING (КОНТРОЛЬ ЧАСТОТЫ) on the front panel of unit No.1;

(d) switch on the heater voltage and the high tension of the transmitter;

(e) the transmitter frequency is checked by listening in the headphones to the beats between the transmitter frequency and that of the heterodyne wavemeter.

10. Operation of the Radio Station under Unfavourable Temperature Conditions

Operation of the Station at Low Temperatures

Operation of the station at low temperatures (down to 40°) is quite permissible if moist air from warm rooms does not enter the station. Moist air can cause condensation on the components of the transmitter and rectifier which are

under voltage as, for example, mica condenser units and selenium stacks, which may lead to creeping discharge and breakdown of insulation.

In addition, icing of contactors and relays may occur making the automatic system and keying circuits inoperative. For this reason when operating under low ambient temperatures and when components are covered with condensation, it is necessary to observe the following rules of operation:

(a) the ventilation devices of the station should be switched on 15 to 20 minutes prior operation;

(b) the heaters of the transmitter valves should be switched on after switching on ventilation (10 minutes prior operation);

(c) switch the transmitter on for 5 minutes as for tuning and only then switch it to normal operation.

It should be noted that until the selenium stacks have warmed up during operation, all the rectifier voltages produced by the rectifiers will be below (by 5-6 per cent) the nominal values, but as the stacks warm up normal operating conditions of the transmitter will be established.

Operation of the Station at High Temperatures

Prolonged operation at high ambient air temperatures (up to +50°) is dangerous for the ГУ-80 transmitter valves due to possible overheating of anodes and envelopes and for

the rectifiers due to possible overheating of the selenium stacks.

When operating under such conditions it is necessary to pay special attention to the cooling of selenium stacks and valves and, if possible, to decrease the rectifier load by switching to tuning operation. In order to improve the cooling of the selenium stack units of the rectifier assembly and the ГУ-80 valves, the dust filters should be temporarily removed from the frames of units Nos 3 and 4 of the rectifier and transmitter cabinets, in order to increase the flow of air. At the end of operation the filters should be replaced.

During operation it is necessary to watch the overheating signal lamp of the rectifier. If the lamp lights up, operation should be continued only in urgent cases, as operation with the temperature of the selenium stacks above 75° causes rapid aging of the selenium elements. Simultaneously it is necessary to keep a watch on the colour of the anodes of the ГУ-80 valve through the peep-hole of transmitter unit No.3 (anodes may be heated to cherry red).

B. MAINTENANCE OF THE RADIO STATION

The transmitting radio station can be kept fully serviceable only if the equipment is cared for well and in due time.

All the equipment of the transmitting radio station should be kept clean. This also applies to the rooms where the equipment is installed. It should be borne in mind that the transmitter and rectifier employ a system of forced ventilation which gets its air for cooling the equipment from the radio room.

Maintenance Carried out Once a Fortnight

All the units of the transmitting radio station should be removed from their cabinets and blown with the aid of bellows, a vacuum cleaner, an electric fan, or a jet of compressed air. The units which have been removed may not be placed on the contact knives and guide rods.

Examine the relay contacts and the male and female contacts of switches and connectors of the removed units. Remove traces of deposit and dirt with clean waste moistened with denatured alcohol.

The transmitter employs ganged tuning. In order to avoid detuning and possible breakage of transmitter components when installing the units it is necessary to set the tuning knobs of the 3rd-5th stages to zero scale (fully counter-clockwise) and to set the band selector switch in position 1. The couplings and cams of the ganged tuning mechanisms of all the transmitter units and inside the compartments of the cabinet are set for coincidence of the red lines.

Check the operating conditions of the transmitting radio station and the correspondence of currents and voltages to nominal value. The actual values of current and voltages may differ by not more than 25 per cent from those indicated in the tables. However the readings of the meters should not go outside the limits of the coloured sectors (lines) on the scales of the transmitter and rectifier meters.

Sharp divergence of currents and voltages from the values indicated in the factory tables is an indication of incorrect tuning or faulty equipment. The faults should be eliminated immediately.

The method of checking the operating conditions of the transmitting radio station with a dummy antenna may be recommended. For this, two incandescent lamps of 220 V, 1 kW (or four lamps of 500 V) are connected in parallel, one terminal being connected at the antenna switchboard to the jack of the transmitter being checked, and the other to the jack EARTH.

The connecting wires should be as short as possible.

Check the calibration of the continuous range oscillator with the aid of a heterodyne wavemeter of the second class at crystal control points, or with a heterodyne wavemeter of the first class according to instructions.

Wash the dust filters with gasoline to which 20 per cent motor oil of grade 8 or 10 has been added.

After the liquid has run off the filters, replace the filters in the frames. After drying, the gasoline evaporates, and a thin layer of oil remains on the surface of the filter screens.

When washing the filters with gasoline care should be taken: do not work with an open flame to avoid fires and explosions.

If the dust filters are neglected the filter meshes may clog, decreasing the flow of cooling air, which will cause overheating of the selenium stacks and reduce the time of continuous operation of the station.

Components of the transmitter, especially those of the fifth stage, can also overheat if the supply of air is insufficient.

Monthly Maintenance

Check the operation of relays, contactors, and their contacting reliability. Make sure that contactors 515, 528, 529 and 550 make reliable contact. The units should be removed for checking.

Examine and clean the antenna insulators and the antenna cable of soot and dirt; check the reliability of connections (feeder to antenna, feeder to transmitter terminal ANTENNA).

C. FINDING AND ELIMINATING FAULTS

Serious attention should be paid to the problem of timely finding and eliminating of faults.

A fault can be found and eliminated only by an operator who knows the radio station well and clearly understands the functions of all the components and their interaction.

A superficial knowledge of the control knobs is by no means sufficient for eliminating possible faults.

When localizing a fault the following procedure should be observed. External symptoms serve as a basis for making suppositions concerning the nature and place of the fault, after a check is made to see whether our suppositions conform to the phenomena observed in the radio station.

If a check proves our suppositions to be wrong, new suppositions should be made.

In some of the simpler cases it is possible to determine the place of the fault correctly at the first try.

In general, things are more complicated and the fault can be found only after a number of suppositions, which gradually approach the true cause, have been made.

In this case each subsequent (correct) supposition should cover a smaller and smaller section of the circuit until the last supposition determines the placo of the fault exactly.

In many cases various faults can produce one and the same symptom as for example considerable reduction or complete absence of R.F. current in the antenna.

Special attention should be paid and the radio station switched off when:

(a) sparking is heard during breakdown;

(b) overheating of components occurs, there is a smell of burnt insulation or a smell of ozone;

(c) the white signal lamp lights up, indicating an overload in the 600-volt or 2500-volt circuit;

(d) neon lamps light up when one of the fuses in the control and screen grid circuits, anode and heater circuits of the master oscillator, heater circuits of other valves, burn out;

(e) a neon lamp goes out when one of the fuses has blown or one of the phases is missing in the A.C. mains supplying the rectifiers.

Thus, when a fault has developed it is first of all necessary to sectionalize the faulty unit in the radio station; the power assembly, the rectifier, the transmitter, or the protection of interlocking circuit.

To trace the faulty component, pay attention to the readings of the measuring instruments. Let us suppose that it has been ascertained that the fault is in the transmitter. Further search is confined to the transmitter.

Now it is necessary to localize the unit and stage of the transmitter which is responsible for abnormal reading. This is done by analyzing the readings of the measuring instruments, and sometimes by direct examination of the transmitter.

When the faulty stage has been located, it is necessary to find out which of its circuits is at fault. Having found this out, make additional checks to determine the nature and place of the fault exactly.

The illustrations listed below will be useful to the repairman when he is trouble shooting.

First Case

The A.C. mains voltage is 205 volts. The voltage of the control circuits rectifier (B-1) is 28 volts. The rest of the voltage are missing.

Suppositions concerning the cause of the fault are as follows.

The green signal lamp HEATER (НАКАЛ) is on. The value of the A.C. voltage, 205 volts, is within permissible limits (the station can operate with the mains voltage fluctuations within ±10% of nominal value, i.e. from 198 to 242 volts). The voltage of the control circuits rectifier, 28 volts, is also normal. In practice its value varies from 22 to 30 V.

First we must find the cause of the absence of the stabilized voltage +220 V and the bias voltage -250 V. One phase of the A.C. voltage supplying the primary windings of transformers 556 and 518 of rectifiers B-3 and B-4 (220 volts stabilized and -250 volts), is applied via the contacts of time relay 536. The time relay will operate and its contacts will close provided the toggle switch RADIO-INTERCOM. of the control unit is in the position RADIO and all the units are inserted firmly in the cabinet and screwed down with the securing screws (consequently all the interlocking circuits are closed).

This check convinces us that the +24-volt voltage from wire 115 must reach the anode of valve Л_{10} (valve time relay) via the above-listed circuits.

We switch the transmitter on and become convinced that the +220 and -250 voltages are missing. We check valve Л_{10}. The valve feels warm, it shows that its heater circuit is passing current. We clean the relay contacts. Still there is no voltage. We replace the valve Л_{10} with a new one. After switching the transmitter on, we are convinced that all voltages are present (the 600 and 2500 voltages appear only if the -250 voltage is present).

This means that the fault in this case was due to the loss of emission by the valve Л_{10}, which caused a sharp decrease in its anode current. As the winding of relay 536

Clearly, the main cause of the fault must be the absence of the +24 voltage.

The +24 V rectified voltage appears immediately after power is switched on. We first check fuses 547 of the +24-volt circuit, located in rectifier unit No.1. We find that one of the 6-A fuses has blown. After replacing the fuse we see that the new fuse also burns out. Now we assume that there is a short-circuit to earth in the +24-volt circuit.

Now the place of the short-circuit must be found. We disconnect two connecting wires from terminal 21 of the terminal strip of rectifier B-1. Switching on the rectifier, we see that the +24 voltage is present. Thus the short circuit is not in the rectifier proper.

Switch the power off and check the circuit with a continuity meter or a megger having a voltage of not more than 250 volts (meggers with higher voltages may cause breakdown of bypass capacitors).

The two wires which we had disconnected from terminal 21 lead to the transmitter and from there to the control unit.

One lead of the continuity meter (or megger) is connected to earth, the other, to one of the wires disconnected from terminal 21. Check the wire to see that the given circuit is not shorted. Connect the continuity meter

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One lead of the continuity meter (or megger) is connected to earth, the other, to one of the wires disconnected from terminal 21. Check the wire to see that the given circuit is not shorted. Connect the continuity meter

(or megger) to the second wire and make sure that the given circuit is shorted as indicated by the full deflection of the meter pointer.

Seeing that the given wire leads to the control unit, we remove the control unit from the cabinet. Nevertheless the short-circuit remains. It can be supposed that the +24-volt wire is earthed in the modulator. Removing the modulator unit from the cabinet, we see that the meter pointer has returned to zero (the megger reads an infinitely high resistance). The faulty unit has been found, it now remains to locate the exact place of the short-circuit.

Carefully examining the circuit leading away from terminal 21 in the modulator, we discover that the copper connecting lead of resistor 62 is touching the chassis.

The resistor must be insulated from the chassis, the wires, which were disconnected for checking, reconnected to their terminals, and the transmitter switched on to make sure that all voltage are present.

It is obvious that earthing of the +24-volt circuit can also occur in other units of the transmitter, for example, in case of breakdown of bypass capacitors to earth. In this case the method of finding the fault remains the same.

Third Case

When the transmitter is switched on, the +250 V screen grid voltage and the +600 and +2500 voltages are missing.

Contactors 515 (600 V) and 528 (2500 V) will operate provided the relay winding of the high voltage contactors are supplied with +24 volts via the closed contacts of bias relay 512.

The winding of bias relay 512 is supplied by the -250 voltage. Check to see that the winding of relay 512 is intact, as the voltmeter reads the -250 voltage and the relay has operated.

The contacts of the bias relay (terminal 20 of the rectifier strip) should be supplied with +24 volts from wire 115 in the control unit via the contacts of toggle switch RADIO-INTERCOM. of the control unit, the interlocking contacts of the modulator and transmitter, and the contacts of the function switch in transmitter unit No.5.

The presence of the voltages +220 and -250 allows us to suppose that the +24-volt circuit from terminal 115 of the control unit to terminal 10 of the rectifier is intact (from terminal 10, +24 volts are fed to the anode of the time relay valve $Л_{10}$; operation of this relay shows that the +220 and -250 voltages are present).

Having made sure that the emergency toggle switch is in the position ON and the function switch of transmitter

unit No.5 in the position CONTINUOUS RANGE, we check for the presence of the +24 voltage in the circuit which follows overload relay 537. If the circuit is checked with a continuity meter, the contacts of the bias relay must be closed. Next, we check for the presence of the +24 voltage at the interlock contact of the neon lamp $Л_9$ and in the winding circuit of contactor 515 and see that there is no voltage. Hence, the faulty section has been found. Careful examination discloses a broken wire at the valve holder of the interlock contact of the valve $Л_9$.

The +600-volt and +2500-volt tensions may also be missing due to other faults (poor contacts in components, open circuits, etc.). Check step by step those sections of the circuit, which are likely to develop a fault to locate the place of the fault. In the long run, this time-consuming method is admittedly the quickest and most efficient.

Fourth Case

The anode current of the fifth stage valve is very low, the screen grid current of one of the ГУ-80 valves is very high. There is no antenna current.

The faulty section is supposed to be in the fifth stage.

Checking the voltages at the electrodes of the ГУ-80 valves, we discover that there is no voltage at the

screen grid of the ГУ-80 valve located at the front wall of the unit.

We remove that ГУ-80 valve from its valve holder, which had a high screen current. After switching on again, we discover that the screen grid current is as high as before, even though the valve is removed.

The presence of current in this circuit in the absence of the valve indicates a short in the screen grid supply circuit.

As the screen grids of the fifth stage valves are supplied from rectifier B-5 and the same voltage supplies the anodes of the fourth and third stage valves, the anode currents of which are normal, the only cause of the fault must be a short to earth in the circuit leading from jack 217. Most likely capacitor 183 is broken down.

On checking disconnected capacitor 183, we see that it realy is broken down.

We replace the faulty capacitor with a new one and check the operation of the transmitter. Normal anode current of the fifth stage valves indicates that there are no more faults and that the transmitter operates normally.

Fifth Case

In continuous oscillation, the transmitter operates normally. When switching to telephone operation, there is

no modulation and the transmitter remains in the telegraph operating mode.

In telephone operation the suppressor grids of the ГУ-80 valves should be supplied with a negative voltage of about 190 volts which decreases the anode current of the valves in comparison with that of telegraph operation. The fact that the transmitter remains in the continuous oscillation mode indicates that negative voltage is not supplied to the suppressor grids of the ГУ-80 valves. As there is likewise no modulation (the pointer of the modulation depth meter of the control unit does not deflect), it can be assumed that audio frequency voltage from the secondary winding of the modulation transformer is likewise not supplied to the suppressor grids of the ГУ-80 valves.

On those grounds it can be assumed that the suppressor grid circuit is earthed, which does not disturb telegraph operation, as in this mode the grids should be earthed. In telegraph operation, we check for the presence of negative voltage at the suppressor grids of the ГУ-80 valves and see that it is missing.

Switching the transmitter off, we check the negative voltage circuit at the suppressor grids of the ГУ-80 valves with a 250-volt megger. In checking we use a step-by-step method.

From terminal 8 of the rectifier strip(-250 volts), one cable leads to transmitter, the other to the control unit.

Along one cable, the -250 volts circuit leads to terminal 8 of the main strip of the control unit, then via a jumper to terminal 8 of the second small strip of the control unit, and from there to the beginning of power control potentiometer 82, the end of which is earthed. At potentiometer 82 two new circuits are formed. One leads from switch 83 to terminal 6 of the control unit strip, and then via a jumper to terminal 6 of the main control unit switch and from there via cable to the transmitter. The second circuit leads from part of potentiometer 82 to terminal 110 of the control unit strip and to terminal 110 of the modulator.

Along the second cable, the -250-volt circuit goes to terminal 8 of the transmitter and to potentiometer 144, and from there to the grids of the first and second stage valves and to the grids of the valves of unit No.5.

It is first necessary to find the unit where the fault has occurred. For this, potentiometer 144 is disconnected from earth. At the terminal strip of the rectifier, we disconnect the two cables leading away from terminal 8 and, with the aid of a megger, determine which unit each cable leads to.

After this we connect one lead of the megger to earth and the other to the tip of the cable leading to the control unit. Turning the handle of the megger, we see that the given circuit is not faulty.

Re-connecting the lead of the megger to the cable leading to the transmitter and turning the handle of the megger, we see that it is this circuit which has a cable conductor shorted to earth.

The circuit, from terminal 7 of the transmitter to the valve holder jacks of the suppressor grids of the ГУ-80 valves, includes choke 169 and bypass capacitors 184, 185, 192 and 193.

It can be assumed that one of the capacitors is broken down. Unsoldering the capacitors we check each one separately with the megger. The check shows all capacitors intact. It can now be supposed choke 169 is earthed.

A check is made to prove this supposition. For this we unsolder the wires leading to the choke, check the insulation of the choke with respect to earth with the megger, and see that choke 169 is connected to earth.

Examining the mounting of the choke carefully, we discover that a connection tag is bent and touching the screw securing the ceramic former of the choke to the transmitter chassis. The fault could be due to careless dusting of the transmitter compartment.

By bending the tag to its normal position, we eliminate the fault, and then re-connect all the wires disconnected for checking.

Sixth Case

All the voltages are present and of the normal value. The anode currents of the first and second stage valves are normal, the anode currents of the third and fourth stage valves are high, the anode current of the fifth stage valve is extremely low. There is no antenna current.

Studying the circuit diagram of the transmitter, we analyze the probable causes of high anode currents of the third and fourth stage valves.

The anodes of the third and fourth stage valves should be supplied with +600 volts. The monitoring voltmeter on the rectifier panel reads this voltage. Obviously anode voltage is supplied to the valves, as otherwise there would be no anode current.

The screen grids of the third and fourth stage valves should be supplied with +250 volts. The voltmeter shows that +250 volts are present at the screen grid voltage rectifier. Obviously, +250 volts are supplied to the screen grids of the third and fourth stage valves, as the absence of positive voltage at the screen grids would sharply decrease the anode current.

As the anode current of the fifth stage valves is very low, we check the anode and screen grid voltages of the fifth stage valves with a voltmeter. The voltmeter shows that the voltages are normal.

Next, check the -250-volt circuit.

As the first and second stages operate normally, we check the -250-volt circuit beginning with the third stage.

We check the circuit from terminal 8 of the strip of transmitter unit No.2. We connect the minus lead of the voltmeter to terminal 8, and the plus lead to the chassis. The voltmeter reads the normal -250 volts.

Removing unit No.2 from the cabinet, we place it beside the transmitter and connect it with the aid of the connecting (repair) cable.

Checking with a voltmeter for negative voltage at the control grid of the third, fourth and fifth stage valves, we see there is no bias at the third and fourth stages and that the bias of the fifth stage is -250 volts.

A simple analysis of the circuit indicates that there is an open-circuit in potentiometer 144.

On checking potentiometer 144, we see that the potentiometer winding located after the first tap to the fifth stage is broken.

This means the control grids of the fifth stage valves were receiving the full negative voltage, which cuts them off reducing their anode current to a very low value.

The control grids of the third and fourth stage valves were receiving no negative voltage, hence the high anode current.

To eliminate the fault, it is necessary to reconnect the broken wires.

x

x x

A different fault is possible. For example, excessive anode current of one stage may be due to breakdown of a grid bias circuit bypass capacitor.

Faults are possible, which do not cause disappearance or a sharp decrease of antenna current (voltage). Among such faults are faults of the microphone amplifier circuit or the tone generator.

Should the audio frequency amplifier or the tone generator fail during operation of the transmitter, the anode current will be normal but there will be no modulation.

The absence of modulation can be easily discovered with the aid of the modulation depth indicator located in

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the control unit, on the modulator unit (if the indicator itself is not at fault).

When seeking faults in the modulation circuits (the microphone amplifier or the tone generator), a headphone or a loudspeaker should be used for step-by-step monitoring at various circuits to find the faulty section. The fault can be found by checking each component in the faulty section.

The brief general information given here on the technique of finding the place of the fault in transmitting equipment does not cover all the possible cases met with in practice. However, the method employed for finding faults in the above cases may be successfully used in other similar cases of failure of equipment.

The most common causes of transmitter failure are:

(a) faulty valves;

(b) broken interlocking circuits;

(c) bad contacts;

(d) burnt relay contacts;

(e) open circuit of cable conductors or tips;

(f) faulty fuses (no contact or burnt out);

(g) breakdown of capacitors to chassis;

(h) changed-value or burnt-out resistors;

(i) incorrect actions of the attending personnel.

The attending personnel should remember that often the transmitter does not operate not due to a fault of the transmitter, which takes a lot of time to find, but due to inattention on the part of the personnel attending the station.

For example:

(1) One of the toggle switches via which the +24 volt control circuit current passes (EMERGENCY TOGGLE SWITCH , RADIO-INTERCOM.) is in the off position, or the function switch is in the position CHECKING.

(2) The currents of the first and second stages are normal, the anode currents of the fourth and fifth stages are low, the antenna input is very low. There is no fault, simply the power switch of the control unit is in position 3, which corresponds to 50 per cent power in the antenna.

In some cases the station can remain operative, if the faulty components are excluded from the circuit. A number of bypass capacitors and some resistors can be disconnected in case of breakdown or open circuits. The station will still remain operative, albeit the characteristics will be worse. Here are several examples.

1. In case of damage to one of the rectifier condensers of the anode supply circuit (B-6) or the intermediate (B-5) stages, operation can be continued if both

ends of the faulty condensers are disconnected. This will cause a certain increase in hum in telephone operation and will hardly affect telegraph operation.

2. In case of damage to one of the capacitors at the output of the filter of the rectifier supplying the anode circuit of the master oscillator (B-3), grid bias (B-4) or screen grids (B-2), operation can be continued if the faulty capacitor is disconnected. The quality of telegraph operation will hardly deteriorate in this case, however, disconnection of an input condenser or a rectifier filter will decrease considerably the working voltage and filtering.

When replacing capacitors in the rectifier B-4, attention should be paid to insulating the can of the condenser from the chassis and connecting the polarity right.

3. In case of damage to the selenium stack of one of the rectifiers which supply the anode circuits of the output or intermediate stages (B-6 or B-5), it is possible to continue operation, if the faulty stack is disconnected at both ends. In this case telegraph operation will proceed without noticeable deterioration (the power will be reduced slightly) and hum will increase in telephone operation.

The above examples serve to show how the station can be made operative in a short time, if there is an urgent

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necessity to continue operation. If there is no urgency, the faulty component should be replaced.

D. PRINCIPAL SAFETY RULES

1. General Information

Electric current gives man a shock when it passes through his body. D.C. or A.C. current higher than 100 mA is lethal for man. Currents of from 30 to 100 mA may cause serious injuries, often leading to death.

The value of the current passing through the body depends on the voltage which the body comes in contact with and the resistance of that part of the body to which voltage is applied.

The resistance of the body depends mainly on the condition of the skin at the place where the body comes in contact with live conductors.

The degree of the electric shock also depends on which organs of the body are affected. When current passes through vital organs (the region of the heart, stomach, etc.) danger increases greatly.

In the case of local shocks, for example, when current passes through part of the hand or foot, serious burns may occur.

Any tension above 25-30 volts should be regarded dangerous to life and health. For this reason all possible measures should be taken to prevent the possibility of coming into contact with live components.

It should be remembered that in the case of very high voltages (above 2-3 thousand volts) it can be dangerous to touch not only conductors but even insulators. A thin film of moisture, dirt, dust, and soot may cause a leakage along the surfaces of insulators. For this reason it is very important to pay attention to the surfaces of the insulators, keeping them clean.

High tension devices are considered those which have effective voltages with respect to earth exceeding 220 volts of alternating current and 250 volts of direct current. Devices with lower voltages are conventionally called low tension devices.

In the case of storage batteries the determining voltage is that at the beginning of charging.

High tension radio frequencies (15,000-20,000 c.p.s. and higher) are usually not so dangerous; shocks caused by these voltages are seldom lethal, but do cause serious burns.

2. Safety Measures for Operating with High Tensions

Installation and connection of the radio station and electrical equipment should be carried out with the greatest

possible observance of measures for safeguarding the personnel from electric shocks.

Repairs of the radio station which required periodic switching on of high tension should be carried out by two persons who are acquainted with the given installation and have obtained permission to carry out the work.

Cleaning of the room and wiping of the equipment during operation of the radio station is strictly forbidden.

It is also forbidden to work on the radio station with the signalling circuit and interlocks disconnected (short-circuited); the doors open, casings removed, as well as when there are faults in the signalling circuits, the control and interlocking circuits connected with high-tension protection and the application and removal of high tension.

The places where the equipment is earthed should be well known. The reliability of the earthing of the bodies of electrical machines and equipment should be checked once a quarter when the equipment is switched off.

It is forbidden to replace normal fuses with fuses of other ratings. Fuses must be charged only with elements of calibrated wire of the required cross-section.

In order to replace a burnt-out fuse of the power unit, it is necessary to stop the unit and to discharge

the filter condensers with a special metal rod provided with a well-insulated handle. Rectifier fuses should be replaced only after the supply mains voltage has been switched off.

Should it be necessary to repair or adjust units of the radio station under voltage, all connections (including the connection of connecting cables) should be made with the power units stopped and the rectifier switched off.

It is strictly forbidden to allow untrained personnel to repair and adjust the equipment.

When removing units from the cabinet, (for example, for replacement of valves, improving contacts, etc.) the high tension should first be switched off.

When measuring high tension with portable instruments the following rules should be strictly observed:

(a) the voltmeter should be placed on a firm base and reliably insulated from the earth. It is strictly forbidden to hold the voltmeter in the hands during measurement;

(b) the insulation of the wires used for connecting the voltmeter should correspond to the voltage being measured. The wires of the voltmeter should be connected to the high tension source only after voltage has been first switched off and the terminals of the source checked to see

that there is no high tension, for example, the charge of filter condensers. Checking should be carried out with the aid of an earthed short-circuiter provided with a well insulated handle;

(c) first connect the wire of the voltmeter to the earthed terminal of the high tension source, then the second wire. Having checked that all connections have been made right, step half a meter away from the voltmeter and wires, and without touching them switch on high tension. After this note the reading of the voltmeter.

At the transmitter, power unit or other equipment which has high D.C. or power frequency tension, the deck (floor) should be covered with a rubber mat or other insulating material which can withstand double the working voltage.

It is strictly forbidden to touch wires and terminals under voltage with the fingers in order to find out if voltage is present.

The power unit should operate with the current-carrying parts closed. It is forbidden to leave operating converters with open commutators (without screens), slip rings, as well as control equipment (with cases removed).

Instructions pertaining to the given equipment, covering its switching on and off, repair, and first aid rules in case of electric shock, should be hung on the wall in the rooms where the radio transmitting equipment and power equipment are located.

3. Safety Measures in Working with High Frequencies

It should be borne in mind that although high frequency voltage is not lethal, the burns caused by high frequency current can lead to serious injuries. It is strictly forbidden to touch components carrying high frequency voltage.

It is forbidden to make artificial arcs or sparks in high frequency circuits.

High frequency circuits passing through rooms or living quarters should be shielded off.

Work on transmitting antennas and their lead-ins, as well as work in their immediate vicinities, should be carried out only with permission.

Chapter V

Instructions on Checking and Adjusting the Rectifier and Transmitter

The radio station leaves the factory fully aligned and adjusted. However, individual assemblies of the radio station can become damaged during transportation and storage. For this reason the station must be carefully checked after installation on board the ship. The same check-up should be carried out after medium repair or general overhaul.

Instructions are given below on checking and adjusting the main assemblies of the rectifier and transmitter.

Checking the BC-1 Rectifier Assembly

To check the BC-1 rectifier assembly proceed as follows:

1. Remove all the units (if they are in place) by turn and carry out an external examination.

2. During the examination remove all foreign objects (for example, washers, metal shavings, etc.); make sure all valves and fuses are in place.

3. In units Nos 1, 2 and 3 check the position of the jumpers on the switching panels of the transformers of rectifiers B-1, B-5 and B-6, and if they do not correspond to the supply mains voltage, reset them.

4. Set the units in their places and secure them with screws.

5. Apply mains voltage with the aid of the shipboard switch and check it with the voltmeter, by pressing push-button A.C. LINE (ЛИНИЯ ∼) on the voltmeter switch (unit No.1). Check for the +24 voltage by depressing push-button 24 V (24 B).

6. Switch on heater voltages by pressing push-button START of the control unit and measure them with an A.C. voltmeter having a 30-volt scale. The heater voltages should correspond within ±5 per cent to the values given in Table 8.

7. Switch on high tension with the aid of the toggle switch with RADIO-INTERCOM. of the control unit (the emergency toggle switch of the BC-1 rectifier should be in position ON.

8. Check the voltages of the main circuits of the rectifier with the voltmeter in unit No.1, depressing by turns the push-buttons of the voltmeter switch. If rectifier BC-1 is operating normally, the voltmeter should read the voltages given in Table 9.

Table 8

Circuit	BC-1 terminal No.	Voltage, V
Master oscillator heater	27-28	12.6
Heater of intermediate stage and modulator valves	1-2	13.0
Heater of unit No.5 and antenna indicator valves	11-12	6.5
Heater of power output stage valves	71-72	14.5

Table 9

Push-button of voltmeter switch	Voltmeter reading multiplier	Normal voltage, V	Notes
LINE (ЛИНИЯ)	10	220±10%	
24 V (24 B)	1	28±10%	
GRID, 250 V (CETKA 250 B)	10	250±10%	
MASTER OSCILLATOR ANODE	10	220±2%	
SCREEN GRID 250 V (ЭКРАН 250 B)	10	250±10%	
600 V (600 B)	20	600±10%	
2.5 kW (2,5 KBT)	100	2500±10%	In operating mode
2.5 kW (2,5 KBT)	100	1250±10%	In tuning mode

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On being convinced that all the voltages are normal, attempt to tune and adjust the transmitter.

Checking the Continuous Range Oscillator

Before checking the oscillator it is necessary to examine it and make sure that the master oscillator is fitted with a ГУ-50 valve having a red circle, with the number of the master oscillator on the metal head, or the marking "ЗГ" . After this, check the operating conditions of the oscillator. For this proceed as follows:

(1) set the function switch in the position CHECKING;

(2) set the band selector switch to the first band;

(3) switch the rectifier knife switch to position 1 or 2 (depending on the side supplied with A.C. voltage).

Note: If the station is supplied by a D.C. mains via a converter, first start up the converter.

4. Press the push-button START of the control unit and make sure that normal heater voltage is supplied, and after operation of the time relay, check whether the +220 stabilized voltage is applied.

5. With the aid of a portable milliammeter, check the anode currents of the first and second stage valves on the first four bands at the end and beginning of each band (switch bands with the anode voltage off). The anode

current of the first stage valve should not exceed 35 mA, that of the second stage valve 60 mA.

6. When the check-up of the operating conditions of the oscillator has yielded satisfactory results, depress the push-button STOP (anode and heater voltages are switched off) and switch on the thermostat heater, noting the switching-on time. The white heater signal lamp will light up and go out after 10-20 minutes (depending on the initial temperature); subsequently the lamp should go on and out with intervals of 1-2 minutes.

Three hours after switching on the thermostat, calibration can be checked.

7. Calibration of the oscillator is checked on the first four bands only, as the frequencies of all the subsequent transmitter bands are obtained by means of multiplication of the frequencies of the first four oscillator bands. No less than three points are checked on each band.

8. The documents of the station include a table of permissible deviations in calibration for each band. Calibration should be checked on the frequencies indicated in this table, for subsequent comparison of the results.

9. Calibration should be checked with a heterodyne wavemeter, types 526 or 528. The input of the heterodyne wavemeter is supplied by the radio-frequency cable specially

led out of the transmitter for checking frequency. If a heterodyne wavemeter is permanently installed and intended for checking several transmitters and receivers, the radio frequency cables are connected to it via a special switchboard, with the audio frequency output switched to a special jack on the front panel of the transmitter. To hear the beat frequencies when checking, the headphones are plugged into this jack.

This makes it convenient to measure frequency while standing near the control knobs of the transmitter.

10. If the heterodyne wavemeter is placed near the transmitter only during measurement, the radio frequency voltage for checking is supplied by temporary wiring from the transmitter and the headphones for listening to the beat frequencies are connected directly to the heterodyne wavemeter.

11. The heterodyne wavemeter should be switched on from 1 to 2 hours prior to measuring, so that it could warm up and its components acquire a constant temperature.

12. Set the band selector switch of the transmitter in position 1. Switch on by pressing the START push-button. Measure five minutes after switching on. To do this set the optical dial to the required frequency. Tune the heterodyne wavemeter to the transmitter frequency according to zero beat, having first corrected the wavemeter at the nearest

crystal point. With the aid of the heterodyne wavemeter table, determine the calibration deviation of the transmitter in cycles per second. If the transmitter frequency is below nominal value, enter the result with a minus sign, if it is above nominal value, enter the result with a plus sign.

Beats on frequencies which are multiples of 100 Kc/s are heard in the headphones at different volumes. Therefore, in order to avoid mistakes, calibration should not be checked at the points which are poorly heard.

13. If the frequency deviation is within permissible limits (not more than 100 to 120×10^{-6}), no correction need be carried out.

14. If frequency deviation is greater than 100 to 120×10^{-6}, but does not exceed one or two divisions of the optical scale, calibration should be corrected.

15. If the frequency deviation is so great that it cannot be corrected with the aid of the correction capacitor, this signifies that a serious fault has occurred in the oscillator and that skilled repairman from Signal Units Workshops must be invited.

Warning: Do not open the ceramic cover of the thermostat during operation.

Checking the Tracking of the 3rd, 4th and 5th Stages

The tracking of the third, fourth and fifth stages is checked at two extreme points of the following bands:

(a) the beginning of the ninth and the end of the twelfth bands;

(b) the beginning of the fifth and the end of the eighth bands;

(c) the beginning of the first and the end of the fourth bands.

While checking tracking:

1. Switch on the supply knife switch on the front panel of rectifier unit No.2.

2. Switch on the transmitter valve heaters.

3. Set the toggle switch TUNING-OPERATION (НАСТРОЙКА-РАБОТА) on the front panel of rectifier unit No.1 in the position TUNING (НАСТРОЙКА).

4. Set the function switch in the position CONTINUOUS RANGE.

5. Set the band selector switch to the required band.

6. Set the function switch of the control unit in the position CW, switch on high tension and depress the key.

7. Plug the portable milliammeter in the jack CONTROL GRID, 3rd STAGE (УПР. с. III к.), make sure there is grid

current and re-plug it in the jack ANODE, 3rd STAGE (АНОД III К).

8. Use the tuning knob of the 3rd-5th stages to tune to minimum anode current of the third stage. To exclude spurious tuning (to a harmonic), check the tuning division of the 3rd-5th stage knob against the calibration book or the red numbers on the coarse tuning dial of unit No.1. Note the divisions of the 3rd-5th stages tuning dial.

9. Plug the portable milliammeter into the jack ANODE, 4th STAGE (АНОД IV К) and operate the manual tuning knob of the 3rd-5th stages to tune to minimum anode current of the fourth stage. The division of the 3rd-5th stages tuning dial should now differ from that obtained in Item 8 by not more than 5 divisions at the lowest tuning frequency and not more than two divisions at the highest tuning frequency.

10. At each frequency being checked, tune the intermediate tank circuit to minimum anode current of the fifth stage, using the tuning knob of the fifth stage. On any frequency, the circuit should be tuned sharply (it should have a sharp current minimum).

Should the tuning of the third-fifth stages become untracked, proceed as follows:

1. Check the mechanical ganging of the 3rd-5th stages variometers at three points of the 3rd-5th stages tuning dial. The greatest inductance of the variometers of the third, fourth, and fifth stages should correspond to the beginning of the dial (division 0-00), the least inductance to the dial divisions 8-00. The rotors should be well centred and rotate in synchronism.

2. Set the antenna coupling switch in position 1.

3. Remove the power supply from the screen grids of the ГУ-80 valves, for this disconnect conductors 4^{I} and 4^{II} from the intermediate terminal strip of unit No.3 in the transmitter cabinet.

4. Switch on the power supply knife switch.

5. Switch on the heaters of the transmitter valves.

6. Set the toggle switch TUNING-OPERATION in the position TUNING.

7. Set the function switch in the position CONTINUOUS RANGE.

8. Check whether there is a tuning margin on the tuning dial of the 3rd-5th stages which corresponds to 40-60 divisions at the extreme frequencies of the second band of the fifth stage (6-12 Mc/s). If there is no tuning margin, or if it is greater than it should be, obtain the necessary coverage by adjusting the tap of trimming coil 93 (See Appendix 12), and with trimming

capacitor 106 make the margin on the dial approximately the same for both extreme frequencies.

9. Check whether there is a tuning margin on the tuning dial of the 3rd-5th stages which corresponds to 40-60 divisions at the extreme frequencies of the first band of the fifth stage (3 - 6 Mc/s). If necessary, adjust with trimming coil 94 and trimming capacitor 107, as indicated in Item 8.

10. At the extreme frequencies of the third band of the fifth stage (12 - 24 Mc/s), operate the tuning knob of the 3rd - 5th stages to tune to minimum anode current of the third stage, and use trimming capacitor 132 in the circuit of the fourth stage to tune to minimum anode current of the fourth stage at the highest frequency of the range while at the lowest frequency use trimming coil 119.

Retuning several times in turn at the highest and the lowest frequencies of the band (12 - 24 Mc/s), obtain the required tracking accuracy, after which check tracking at one or two intermediate frequencies.

11. On the second band of the fifth stage (6 - 12 Mc/s) tracking is obtained in the same way as indicated in Item 10. To obtain tracking capacitor 129 with taps and trimming coil 118 are used.

12. On the first band of the fifth stage (3 - 6 Mc/s) tracking is obtained in the same way as indicated in Item 10. To obtain tracking, only capacitor 128 with taps is used.

13. After tracking has been obtained, switch off high tension by depressing the push-button STOP on the control unit. Re-connect the supply wires of the screen grids of the ГУ-80 valves.

14. Switch on high tension (the toggle switch TUNING-OPERATION is in the position TUNING).

Check the tuning of the anode circuit of the fifth stage with the aligning knob "V" throughout the whole range of the transmitter. At any frequency the circuit should tune sharply (have a clear minimum).

15. If the tank circuit of the fifth stage does not tune sharply, retune. For this purpose use trimming coils 172 and 173 and capacitors 194 and 195 on the third band (12 - 24 Mc/s); coils 174 and 175 on the second band (6 - 12 Mc/s); and coils 170 and 171 and the set of capacitors 196 and 197 on the first band (3 - 6 Mc/s).

Checking the Fixed Frequency Oscillator

The fixed frequency oscillator is checked for the whole set of devices Б . The following is the checking procedure:

1. Earth the antenna, for this set the series capacitors switch in position 5. Set the antenna coupling switch in position 1.

12. On the first band of the fifth stage (3 - 6 Mc/s) tracking is obtained in the same way as indicated in Item 10. To obtain tracking, only capacitor 128 with taps is used.

13. After tracking has been obtained, switch off high tension by depressing the push-button STOP on the control unit. Re-connect the supply wires of the screen grids of the ГУ-80 valves.

14. Switch on high tension (the toggle switch TUNING-OPERATION is in the position TUNING).

Check the tuning of the anode circuit of the fifth stage with the aligning knob "V" throughout the whole range of the transmitter. At any frequency the circuit should tune sharply (have a clear minimum).

15. If the tank circuit of the fifth stage does not tune sharply, retune. For this purpose use trimming coils 172 and 173 and capacitors 194 and 195 on the third band (12 - 24 Mc/s); coils 174 and 175 on the second band (6 - 12 Mc/s); and coils 170 and 171 and the set of capacitors 196 and 197 on the first band (3 - 6 Mc/s).

Checking the Fixed Frequency Oscillator

The fixed frequency oscillator is checked for the whole set of devices Б . The following is the checking procedure:

1. Earth the antenna, for this set the series capacitors switch in position 5. Set the antenna coupling switch in position 1.

2. Plug a Б device into the recess of unit No.5.

3. Set the function switch (of unit No.5) in the position CRYSTAL (КВАРЦ).

4. Set the band selector switch of the transmitter according to the frequency indicated on device Б.

5. Set the toggle switch OPERATION-TUNING in the position TUNING, switch on high tension, and depress the key.

6. Use the continuous tuning knob of transmitter unit No.1, to tune the second stage tank circuit to maximum grid current of the third stage.

7. Tune the third and fourth stages to maximum control grid current of the fifth stage valves. Tune the fifth stage to maximum anode current. The resulting value of the third stage grid current should not be less than that indicated in the tuning book.

It should be noted that the fixed crystal frequencies may not coincide with the readings of the optical dial of the continuous range oscillator, as in this case the tank circuit of the oscillator second stage is tuned to the frequency of the crystal oscillator and tracks with the tuned circuit of the master oscillator with a certain tolerance in either direction. The continuous range oscillator does not function in this case.

8. Set the function switch in the position FREQUENCY-SHIFT KEYING OSCILLATOR (ВЧМ) and check for frequency deviation. For this the heterodyne wavemeter is tuned by zero beat to the crystal oscillator frequency, with the key released. When the key is depressed, a tone should be heard in the earphones of the heterodyne wavemeter, which corresponds approximately to the deviation frequency.

9. Printing telegraphy is checked by connecting the line from the telegraph set to terminals 18 and 0 of the control unit, with the plus of the line supply source of the telegraph set connected to terminal 18.

10. Having carried out the first eight operations listed above and intended for checking the frequency-shift keying oscillator with any one of the Б devices, proceed to checking printing operation by starting up the telegraph set.

When depressing the keys of the telegraph set, tone keying should be heard in the headphones of the heterodyne wavemeter or of an auxiliary receiver tuned in the CW mode to zero beat with the key released.

If no tone keying is heard in the headphones, it is first necessary to check the 24-volt circuit against the circuit diagram.

The keying relay is adjusted at the factory with the aid of a special circuit employing an audio oscillator and an oscillograph.

The frequency of the crystal oscillator is checked only with the aid of a primary frequency standard having an accuracy of no less than 5×10^{-7}.

Checking Remote Communication Posts

1. Check the remote communication posts for proper operation having first checked the line conductors leading from the remote post to the radio station via the switchboard.

2. As most of the line conductors are interconnected and connected to earth through various circuits of the equipment, check them with a continuity tester having first disconnected all the ends of the line cable. Any wire not connected to earth can serve as the return line.

3. Each line conductor should be checked for continuity, for absence of connection to earth, and for correct connection of the ends of the wire to the strips of the control unit and radio operator's post or remote communication post.

Such checking can be easily and speedily carried out thanks to the hinged panels of the remote posts. When the modulator unit is removed from the control unit of the radio station the terminal strip of the line conductors is also made quite accessible.

4. Having checked for correct connections, switch on the supply knife switch and use a voltmeter to check mains voltage and the 24-volt voltage at the rectifier. If the voltmeter reads zero or a voltage of only about 20 volts, this means that a fuse has blown or that both 6-A fuses of the 24-volt circuit (in rectifier unit No.3) have blown. With a voltage of about 20 volts, operation from the remote posts is impossible.

5. If fuses have blown, it can be assumed that the 24-volt circuit is shorted to earth. In this case it is necessary to switch off the supply, disconnect the switchboard, and check the 24-volt circuits of the station and the remote post separately, consulting the circuit diagram.

6. Having remedied the discovered fault, re-connect the remote post and the radio station. Following the instructions for operating from the posts, carry out in turn all the operations listed in the instructions. If an operation cannot be carried out, open the hinged panel of the remote post and, with the aid of a D.C. voltmeter, check the circuits involved in the operation, consulting the circuit diagram.

A p p e n d i x 1

NOMINAL VALUES OF MAIN PARAMETERS OF THE KB-1 TRANSMITTING RADIO STATION

1. Power consumption:

(a) with A.C. supply: 5 kW (power factor: 0.8);

(b) with D.C. supply: 7 kW.

2. With artificial air cooling (not less than 15 m^3 of air per minute) and the temperature of the cooling air not more than $+50^0$, the transmitting radio station maintains normal round-the-clock operation under the following conditions:

(a) at various temperatures of the ambient air from 0 to $+50^0$;

(b) at a relative air humidity of not more than 95 per cent (with the ambient air temperature $+20^0$).

3. Without forced ventilation, the radio station can operate continuously with any supply version for not more than 20 minutes.

4. The working temperature maintained in the thermostats is $60^{\circ} \pm 1^{\circ}$. The time it takes the thermostat to heat up to the working temperature is 2-3 hours.

5. The optical dial of the transmitter oscillator is calibrated in kilocycles per second, while the calibration points are made in the following way:

in bands 3 to 4 every 1 Kc/s

in bands 5 to 8 every 2 Kc/s

in bands 9 to 12 every 5 Kc/s

6. The power of the transmitter in the continuous range and on crystal-controlled fixed frequencies developed across a wire-wound resistor of 60 - 70 ohms is not less than 1000 watts in CW operation and 250 watts in modulated-oscillation operation.

7. The modulator of the transmitter has a frequency response of from 100 to 5,000 c.p.s. with an irregularity (in voltage) of ± 2 db of the average level.

8. The value of non-linear distortion of the transmitter at 80 per cent modulation and a modulating tone frequency of 1000 c.p.s. does not exceed 10 per cent.

9. The frequency of the tone generator of the transmitter is 1,000 c.p.s. ± 10 per cent.

10. The depth of modulation in tone telegraphy is not less than 80 per cent.

11. The level of parasitic hum (ripple voltage) at 100 per cent modulation is not more than 1.2 per cent of the signal value.

12. The maximum telegraph keying rate is 30 words per minute.

13. The insulation resistance of the transmitter H.V. circuits with respect to the chassis is not less than 5 megohms (with the exception of insulation of by-pass and filter capacitors).

Appendix 2

NOMINAL VALUES OF MAIN PARAMETERS OF THE BC-1 RECTIFIER ASSEMBLY

Description of circuit	Voltage, V	Current, A	Ripple, per cent	Voltage stabilization with mains voltage variation of ±10 per cent
1	2	3	4	5
Rectifiers				
Auxiliary circuits (B-1)	24 ±3%	4	-	-
Anode and screen grid voltages (B-2)	250 ±3%	0.1	0.05	-

1	2	3	4	5
Anode of master oscillator valve (B-3)	220 ±10 V	0.05	0.05	±1%
Grid bias (B-4)	250 ±3%	0.1	0.05	-
Anode circuits of intermediate stages and screen grids of power output valve (B-5)	600 ±3%	0.6	0.10	-
Anode circuits of output stage (B-6)	2500 ±3%	1.2	0.15	-
A.C. circuits				
Output stage valve heater	14.5 ±3%	20	-	-
Master oscillator valve heater	12.6 ±3%	0.7-0.83	-	2%
Heater of crystal oscillator and electronic stabilizer valves	6.5 ±3% 6.5 ±3%	2.8 1.0	- -	- -
Heater of intermediate stage valve and modulator valves	13 ±3%	6.8	-	-
Supply of auxiliary circuit	220 ±3%	1.0	-	-

Note: The values given in the table correspond to a supply mains voltage of 220 or 380 volts with phase voltage deviations of not more than 1 per cent of the nominal value.

1. The BC-1 provides trouble-free operation with fluctuations of the mains voltage within ± 10 per cent and variation of the mains voltage from 45 to 65 c.p.s.

2. With a change of the load current from 0.9 A to zero (with the 50,000-ohm ballast resistor connected) the voltage of the B-6 rectifier increases by no more than 12 per cent, while that of the B-5 rectifier increases by no more than 10 per cent when the load current changes from 0.6 A to zero (with the 20,000-ohm ballast resistor connected).

3. The measuring error of the voltmeter and the ammeter within the working range is within ± 2.5 per cent.

4. With artificial ventilation which provides a flow of not less than 550 m^3 of air per hour through the rectifier, the BC-1 can operate continuously for a long time at ambient air temperatures of from -25^0 to $+50^0$.

5. During prolonged and continuous operation with artificial ventilation providing a flow of not less than 550 m^3 of air per hour through the rectifier and with supply mains voltages of the nominal values of 220

or 380 volts, the selenium elements of the BC-1 overheat by not more than 25°.

6. In the absence of ventilation (emergency operation) and when the equipment has a cold start the BC-1 can operate continuously for 20 min., in which case the selenium elements will overheat by not more than 55°.

Note: The selenium stacks are said to be cold when their temperature exceeds the ambient air temperature by not more than 1°.

7. The efficiency of the BC-1 at nominal load is not less than 65 per cent.

8. The BC-1 can operate inclined in any direction to 45°.

Appendix 3

NOMINAL VALUES OF MAIN PARAMETERS OF CONVERTERS

1. Table of Electrical Parameters

Type of converter	Description and type of machine	Power, kW	Voltage, V	Current, A	Type of current	Speed, r.p.m.	A.C. frequency, c.p.s.	Power factor
П-7.2	Motor ПН-85	9	110 or 220	-	D.C.	1500	-	-
	Three-phase synchronous generator АПНТ-85	7.2	220	22.4	A.C.	1500	50	0.8
ПТ-5	Motor	7.7	110 or 220	-	D.C.	1500	-	-
	Three-phase synchronous generator	5	220	15.5	A.C.	1500	50	0.85

2. The motor of the П-7.2 converter is designed for prolonged operation with fluctuations of the supply mains voltage of ±10 per cent from nominal value.

3. The motor of the ПТ-5 converter is designed for operation with fluctuations of the supply mains:

(a) at rated 110 volts from 95 to 170 volts;

(b) at rated 220 volts from 175 to 320 volts.

4. With various values of mains voltage the ПТ-5 converter can operate continuously for the following periods:

No.	Mains voltage fluctuations		Period of operation
	for U_{mains}=110 V	for U_{mains}=220 V	
1	-	175-195 V	30 minutes
2	95-105 V	195-210 V	1 hour
3	105-130 V	210-265 V	Prolonged
4	130-155 V	265-300 V	1 hour
5	155-170 V	300-320 V	30 minutes

Note: The period of operation under conditions 1, 2, 4 and 5 is determined for a cold start. If the converters have a warm start the operating periods should be reduced by 20-50 per cent, with the exception of condition 3 which allows 24-hour operation regardless of the initial condition of the converter.

5. Converters П-7.2 and ПТ-5 can operate normally at ambient air temperatures not exceeding +40°.

6. The armatures of the converters rotate clockwise (as seen from the motor commutator side).

TABLE OF MEAN VALUES OF VOLTAGES AND CURRENTS OF THE KB-1 TRANSMITTER VALVES IN TELEGRAPH (KEY DOWN AND UP) AND TELEPHONE OPERATION

Unit No.	Valve type	Position	Mode of operation	Current				Voltage			
				I_f, A	I_a, mA	I_{g_1}, mA	I_{g_2}, mA	U_f, V	U_a, V	U_{g_1}, V	U_{g_2}, V
1	ГУ-50	1st stage	CW (key down)	0.7—0.83	25	—	0.8—2.4	12.6	218	—	70
			CW (key up)	0.7—0.83	0	—	0	12.6	230	—	—20
			Phone	0.7—0.83	25	—	—	12.6	218	—	70
	ГУ-50	2nd stage	CW (key down)	0.7—0.83	35	1.5—5	1.5—2	12.6	235	—32	160
			CW (key up)	0.7—0.83	0	—	—	12.6	250	—31	220
			Phone	0.7—0.83	35	—	—	12.6	235	—32	160
2	ГУ-50	3rd stage	CW (key down)	0.7—0.83	40	2.35	—	12.6	630	—60	230
			CW (key up)	0.7—0.83	0	0	—	12.6	630	—60	280
			Phone	0.7—0.83	40	2.3	—	12.6	630	—60	230
	ГУ-50	4th stage	CW (key down)	0.7—0.83	125	0.36	—	12.6	630	—120	270
			CW (key up)	0.7—0.83	0	0	—	12.6	630	—98	270
			Phone	0.7—0.83	120	0.3	—	12.6	630	—120	270
	ГУ-50	4th stage	CW (key down)	0.7—0.83	125	0.36	—	12.6	630	—120	270
			CW (key up)	0.7—0.83	0	0	—	12.6	630	—98	270
			Phone	0.7—0.83	120	0.3	—	12.6	630	—120	270
3	ГУ-80	5th stage	CW (key down)	10.5	400	19	130	12.6	2450	—225	570
			CW (key up)	10.5	0	0	—	12.6	2650	—180	630
			Phone	10.5	250	23	140	12.6	2500	—225	580
	ГУ-80	5th stage	CW (key down)	10.5	400	19	130	12.6	2450	—225	570
			CW (key up)	10.5	0	0	—	12.6	2650	—180	630
			Phone	10.5	250	23	140	12.6	2500	—225	580
4	6X6	Ant. indicator	—	0.3	—	—	—	6.3	—	—	—

APPENDIX 5

TABLE OF TYPICAL OPERATING CONDITIONS OF THE KB-1 TRANSMITTER

Ranges	Frequency, Kc/s	Mode of operation	Tuning of 3rd—5th stages	Tuning of 5th stage	Position of antenna coupling switch	Position of antenna circuit switch: series	Position of antenna circuit switch: parallel	Antenna circuit tuning (approx.)	Mains voltage, V	Currents in valve circuits, mA: 1st stage I_a	2nd stage I_a	3rd stage I_{g_1}	3rd stage I_a	4th stage I_{g_1}	4th stage I_a	5th stage I_{g_1}	5th stage I_{g_2} 1st valve	5th stage I_{g_2} 2nd valve	5th stage I_a	Anode voltage 5th stage, V	Antenna indicator reading	Dummy antenna current, A	Dummy antenna power, V	Modulation factor, per cent
I	3000	CW	0.66	35	10	3	1	6.22	200	20	35	3.0	45	0.7	130	24	120	125	630	2350	0.5	3.7	960	
									220	20	40	3.3	50	0.8	160	32	160	165	700	2600	0.6	4.2	1230	
									240	20	50	3.2	55	0.8	180	39	195	200	800	2900	0.8	4.6	1480	
		TP	0.66	35	10	3	1	6.22	220	20	40	3.2	50	0.7	150	36	165	165	375	2600	0.3	2.3	370	80
IV	6000	CW	7.10	36	10	2	1	5.10	200	30	30	1.4	45	0.2	120	15	95	95	850	2350	0.3	3.2	700	
									220	30	30	1.0	55	0.1	135	20	130	125	970	2600	0.6	3.7	960	
									240	30	35	0.8	60	0.1	160	24	160	150	1075	2900	0.8	4.1	1180	
		TP	7.10	36	10	2	1	5.10	220	30	35	1.0	55	0.1	130	23	150	140	500	2600	0.2	2.0	280	80
V	6000	CW	1.50	23	10	2	1	5.20	200	20	35	3.2	30	0.2	100	22	120	130	800	2350	0.8	4.3	1300	
									220	20	40	3.3	30	0.2	110	28	150	160	900	2600	0.5	4.8	1600	
									240	20	45	3.5	35	0.2	120	33	180	190	950	2900	1.2	5.2	1900	
		TP	1.50	23	10	2	1	5.20	220	20	40	3.3	30	0.1	120	34	175	170	450	2600	0.4	2.5	440	80
VIII	12000	CW	7.02	45	10	1	1	5.50	200	30	30	1.5	30	0.1	100	13	90	105	700	2350	0.3	3.6	900	
									220	30	30	1.3	30	0.1	115	16	115	130	750	2600	0.4	4.0	1100	
									240	30	35	0.7	35	0.1	130	20	150	160	850	2900	0.5	4.5	1400	
		TP	7.02	45	10	1	1	5.50	220	30	30	1.2	30	0.1	110	20	145	145	450	2600	0.3	2.3	370	80
IX	12000	CW	1.64	0.6	11	1	1	5.13	200	20	40	3.6	45	0.6	90	8	75	90	700	2350	0.3	3.8	1000	
									220	20	40	3.8	50	0.8	100	10	90	110	775	2600	0.4	4.2	1230	
									240	20	50	4.0	55	1.0	110	12	115	145	850	2900	0.5	4.7	1550	
		TP	1.64	0.6	11	1	1	5.13	220	20	40	3.9	50	0.7	100	13	130	135	450	2600	0.3	2.5	440	80
XII	24000	CW	7.05	34	5	1	1	1.78	200	30	30	1.8	35	0.1	110	7	100	100	750	2350	2.5	3.0	630	
									220	30	35	1.4	40	0.2	125	9	110	110	950	2600	3.0	3.5	850	
									240	30	35	1.0	45	0.2	140	10	115	115	1000	2900	4.0	4.1	1180	
		TP	7.05	34	5	1	1	1.78	220	30	30	1.3	35	0.1	125	12	105	130	600	2600	2.0	2.4	400	80

Note: Stabilized voltage: 220 V; dummy antenna resistance: 70 ohms.

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Appendix 6

TABLE OF FUSES

Description	Type	Current, A	Number per version		
			D.C. 110 V	D.C. 220 V	A.C. 220/380 V
Fuse	A-43	2	6	4	5
Fuse	A-43	1	-	2	-
Fuse	A-43	3	-	2	-
Fuse	A-43	5	2	-	-
Tube fuse, 250 V	-	100	4	-	-
Ditto	-	60	-	4	-
Thermal cut-out	-	-	5	5	5
Fuse links	ПК-43-0.5	0.5	5	5	5
Ditto	ПК-43-5	5	1	1	1
Ditto	ПД-I	10	3	3	3
Ditto	ПД-II	6	3	3	3

Appendix 7

LIST OF COMPONENTS FOR TRANSMITTER KB-1

(See Appendix 12)

Circuit No.	Description and type	Quantity	Electrical data
1	2	3	4
	Unit No.1		
1	Valve ГУ-50	1	-
2	Variometer	1	$L_{min.} = 3.5$ µH
			$L_{max.} = 6.4$ µH
3	Choke	1	230 µH ±10%
4	Band selector switch	1	—
5	Condenser of fourth band tuned circuit consisting of:		
	КГК-С-890-I	1	Selected during alignment
	КГК-С-56-II	1	
	КГК-Ж-68-II	1	
6	Condenser of third bank tuned circuit consisting of:		
	КГК-С-200-I	1	Selected during alignment
	КГК-С-27-II	1	
	КГК-Ж-39-II	1	

1	2	3	4
7	Condenser of second band tuned circuit consisting of:		
	КГК-С-330-I	1	Selected during alignment
	КГК-С-39-II	1	
	КГК-Ж-68-II	1	
8	Condenser of first band tuned circuit consisting of:		
	КГК-С-390-I	1	Selected during alignment
	КГК-С-80-II	1	
	КГК-С-56-II	1	
	КГК-Ж-56-II	1	
9	Capacitor, trimming	1	1-3 pF
10	Ditto	1	1-3 pF
11	Ditto	1	1-3 pF
12	Ditto	1	1-3 pF
13	Capacitor КГК-М-400-I	1	400 pF; 1000 V
14	Capacitor КГК-М-400-I	1	400 pF; 1000 V
15	Capacitor КГК-М-450-I	1	450 pF; 1000 V
16	Ditto	1	450 pF; 1000 V
17	Capacitor КГК-М-1000-I	1	1000 pF; 1000 V
18	Condenser КГК-М-51-I	1	51 pF
19	Condenser, bypass КСО-6-500-Б-5100-II	1	5100 pF; 500 V
20	Condenser, bypass КСО-6-500-Б-8200-II	1	8200 pF; 500 V

1	2	3	4
21	Condenser, bypass KCO-6-500-A-8200-II	1	8200 pF; 500 V
22	Choke	1	1 μH ±5%
23	Relay, high frequency, У-171.73.30	1	-
24	Resistor BC-1.0-560 ±10%	1	560 kilohms; 1 W
25	Resistor BC-2.0-10 ±5%	1	10 kilohms; 2 W
26	Choke, anti-parasitic	1	-
27	Valve ГУ-50	1	-
28	Variometer	1	$L_{min.}$ = 3.5 μH $L_{max.}$ = 6.4 μH
29	Choke trimming	1	
30	Capacitor KTK-1-Ж-II, fourth band tuned circuit	1	30-45 pF, selected
31	Capacitor KTK-1-Ж-II, third band tuned circuit	1	25-45 pF, selected
32	Capacitor KTK-1-Ж-75-II, second band tuned circuit	1	75 pF ±10%
33	Capacitor KTK-1-Ж-100-II, first band tuned circuit	1	100 pF ±10%
34	Condenser, trimming TKH-1	1	8-30 pF

1	2	3	4
35	Condenser, trimming ТКН-1	1	8-30 pF
36	Ditto	1	8-30 pF
37	Ditto	1	8-30 pF
38	Capacitor КТК-4М-200-II	1	200 pF; 1000 V
39	Capacitor КСО-7-500-А-10000-II	1	10000 pF; 500 V
40	Capacitor КСО-7-500-А-10000-II	1	10000 pF; 500 V
41	Capacitor КСО-7-500-А-10000-II	1	10000 pF; 500 V
42	Capacitor КТК-1-Ж-150-II	1	150 pF; 1000 V
43	Capacitor КБГ-МП-2в-200-$\frac{1}{И}$-III	1	1 μF; 200 V
44	Capacitor КСО-7-500-А-10000-II	1	10000 pF; 500 V
45	Capacitor КСО-2-500-А-510-II	1	510 pF; 500 V
46	Capacitor КСО-6-500-А-620-II	1	620 pF; 500 V
47	Band selector switch	1	
48	Resistor ВС-1.0-27 ±10%	1	27 kilohms; 1 W
49	Resistor ВС-1.0-6.8 ±10%	1	6.8 kilohms; 1 W
50	Resistor ВС-1.0-47 ±10%	1	47 kilohms; 1 W
51	Resistor ВС-1.0-47 ±10%	1	47 kilohms; 1 W
52	Resistor ВС-0.25-100 ±10%	1	100 kilohms; 0.25 W
53	Resistor ВС-0.25-22 ±10%	1	22 kilohms; 0.25 W
54	Resistor ВС-1.0-100 ±10%	1	100 kilohms; 1 W

–	2	3	4
55	Motor, alternating current for 110 V, type СЛ-262	1	–
56	Resistor, vitrified, type V-400	2	400 ohms each
	Ditto, type V-3/100+200 (connected in series)	1	500 ohms
57	Relay РМ-У-171.71.32	1	–
58	Resistor, vitrified, type 1-400	1	400 ohms
59	Resistor, vitrified, type 1-300	1	300 ohms
60	Resistor, vitrified, type 1-300	1	300 ohms
61	Resistor, vitrified, type 1-25	1	25 ohms
62	Resistor, vitrified, type 1-500	1	500 ohms
63	Heating element	1	900 ohms
64	Thermal fuse	1	Operating temperature 80°
65	Contact thermometer 60°	1	–
66	Lamp, miniature	1	6.3 V; 0.28 A
67	Relay РМУ-171.71.32	1	–
68	Lamp СМ-11	1	13 V; 5 W
69	Toggle switch, two-pole	1	–
70	Choke, blocking	1	–
71	Ditto	1	–
72	Capacitor КСО-7-500-А-10000-II	1	10000 pF; 500 V
73	Capacitor КБГ-М2-200-0.1-III	1	0.1 μF; 200 V

1	2	3	4
74	Capacitor КБГ-М-2-400-0.25-III	1	0.25 μF; 400 V
75	Capacitor КБГ-М-1-400-0.25-III	1	0.25 μF; 400 V
76	Toggle switch, two-pole	1	-
77	Shunt for 50-mA milliammeter	1	Calibrated with
78	Shunt for 250-mA milliammeter	1	instrument
79	Jack No.3560	1	-
80	Ditto	1	-
81	Telephone jack	1	-
82	Capacitor КСО-5-500-А-10000-III	1	10000 pF; 500 V
83	Capacitor КБГ-М-2-200-0.1-III	1	0.1 pF; 200 V
84	Resistor, vitrified, type 1-300	1	300 ohms
	Unit No.2		
91	Valve ГУ-50	1	-
92	Variometer of 3rd stage tuned circuit	1	$L_{min.}$ = 2.25 μH $L_{max.}$ = 12 μH
93	Choke, trimming, of first and second bands	1	-
94	Choke, trimming, of first band	1	-
95	Choke, anode, 3rd stage	1	36 μH
96	Choke, screen grid, 4th stage	1	36 μH
97	Capacitor КСО-2-500-Б-24-II	1	24 pF; 500 V

1	2	3	4
98	Capacitor KCO-5-500-A-10000-II	1	10000 pF; 500 V
99	Capacitor KCO-8-1000-A-10000-II	1	10000 pF; 1000 V
100	Capacitor KCO-5-500-A-10000-II	1	10000 pF; 500 V
101	Mica capacitor	1	180 pF
102	Ditto	1	800 pF
103	Ditto	1	200 pF
104	Ditto	1	200 pF
105	Condenser, trimming, TKH-1	1	8-30 pF
106	Condenser, air trimming	1	$C_{max.} = 45$ pF
107	Ditto	1	$C_{max.} = 45$ pF
108	Resistor BC-1-22 ±10%	1	22 kilohms; 1 W
109	Resistor BC-1-5.6 ±10%	1	5600 ohms; 1 W
111	Shunt for 250-mA milliammeter	1	Calibrated with instrument
112	Jack No.3560	1	-
113	Jack No.3560	1	-
114	Valve ГУ-50	1	-
115	Ditto	1	-
116	Variometer	1	$L_{min.} = 1.15$ µH $L_{max.} = 6$ µH
117	Ditto	1	$L_{min.} = 1.15$ µH $L_{max.} = 6$ µH

1	2	3	4
118	Choke, trimming, of first and second bands	1	-
119	Choke, trimming, of third band	1	-
120	Choke, anode, 4th stage	1	-
121	Choke, screen grid, 5th stage	1	36 μH
122	Capacitor КСО-5-500-А-10000-II	1	10000 pF; 500 V
123	Ditto	1	10000 pF; 500 V
124	Ditto	1	10000 pF; 500 V
125	Ditto	1	10000 pF; 500 V
126	Ditto	1	10000 pF; 500 V
127	Mica capacitor	1	400 pF
128	Ditto	1	386 pF
129	Ditto	1	21 pF
130	Ditto	1	30 pF
131	Capacitor КЗКБ-1-68-II	3	Connected in parallel
132	Condenser, trimming	1	$C_{max.}$ = 20 pF $C_{min.}$ = 3-5 pF
133	Capacitor КСО-8-1000-А-10000-II	1	10000 pF; 1000 V
134	Capacitor КБГ-М1-600-0.15-II	1	0.15 μF; 600 V
135	Capacitor КБГ-М1-600-0.1-II	1	0.1 μF; 600 V
136	Capacitor КСО-8-1000-А-10000-II	1	10000 μF; 1000 V
137	Resistor ВС-0.5-100 ±10%	1	100 ohms; 0.5 W

1	2	3	4
138	Resistor BC-0.5-100 ±10%	1	100 ohms; 0.5 W
139	Ditto BC-2-4.7 ±10%	1	4700 ohms; 2 W
140	Ditto BC-0.5-15 ±10%	1	15000 ohms; 0.5 W
141	Ditto BC-2-1 ±10%	1	1000 ohms; 2 W
143	Resistor, vitrified, type III-500	1	500 ohms
144	Potentiometer	1	2x3100 ohms
146	Shunt for 250-mA milliammeter	1	-
147	Capacitor KCO-5-500-A-10000	1	10000 pF; 500 V
148	Jack No.3560	1	-
149	Ditto No.3560	1	-
150	50-mA milliammeter M-52	1	-
151	Band switch, 3rd stage	1	-
152	Band switch, 4th stage	1	-
	<u>Unit No.3</u>		
161	Valve ГУ-80	1	-
162	Ditto	1	-
163	Choke, anti-parasitic	1	-
164	Ditto	1	-
165	Heater choke	1	-
167	Ditto	1	-
169	Choke	1	-

1	2	3	4
170	Choke	2	-
171	Ditto	2	-
172	Choke, trimming	1	-
173	Ditto	1	-
174	Ditto	1	-
175	Ditto	1	-
176	Choke, anode	1	56 μH
177	Ditto	1	56 μH
178	Variometer	1	$L_{min.}$ = 2.1 μH $L_{max.}$ = 12.7 μH
179	Ditto	1	$L_{min.}$ = 2.1 μH $L_{max.}$ = 12.7 μH
180	Band switch, 5th stage	1	-
181	Ditto	1	-
182	Capacitor KCO-8-1000-A- -10000-III	1	10000 pF
183	Ditto KCO-8-1000-A-10000-III	1	10000 pF
184	Ditto KCO-7-1000-A-1000-III	1	1000 pF
185	Ditto KCO-7-1000-A-1000-III	1	1000 pF
186	Ditto KCO-6-500-A-18000-III	2	18000 pF two, connected in parallel

1	2	3	4
187	Capacitor KCO-8-500-A-18000-III	2	18000 pF two, connected in parallel
188	Ditto	2	8200 pF two, connected in parallel
189	Ditto	2	8200 pF two, connected in parallel
190	Capacitor KCO-5-500-A-10000-III	1	10000 pF
191	Capacitor, type II	1	0.1 μF; 3 kV
192	Mica capacitor	1	4000 pF
193	Ditto	1	4000 pF
194	Capacitor	1	15-20 pF
195	Ditto	1	15-20 pF
196	Capacitor, tuned circuit	1	200 pF ±3%
197	Ditto	1	200 pF ±3%
198	Capacitor	1	1000 pF ±5%
199	Ditto	1	1000 pF ±5%
200	Capacitor, isolating	1	12000 pF; 2.5 kV
201	Ditto	1	12000 pF; 2.5 kV
202	Potentiometer, capacitive А) 2500 pF; Б) 4500 pF; В)4500 pF Г) 4500 pF; Д) 3500 pF; Е)3500 pF Ж) 3500 pF; З) 2000 pF; И)2000 pF К) 1000 pF; Л) 1000 pF	1	-

1	2	3	4
203	Potentiometer, capacitive А') 2500 pF; Б') 4500 pF; В') 4500 pF; Г') 4500 pF; Д') 3500 pF; Е') 3500 pF; Ж') 3500 pF; З') 2000 pF; И') 2000 pF; К') 1000 pF; Л') 1000 pF	1	-
204	Ammeter ПМ-70	1	For 2 A
205	Resistor, silit	1	20 ohms; 5 W
206	Ditto	1	20 ohms; 5 W
207	Resistor ВС-5-51 ±5%	1	51 ohms; 5 W
208	Ditto	1	51 ohms; 5 W
209	Resistor ВС-5-51 ±5%	1	51 ohms; 5 W
210	Ditto	1	51 ohms; 5 W
211	Resistor ВС-2-470 ±10%	1	470 kilohms; 2 W
212	Ditto	1	470 kilohms; 2 W
213	Resistor, silit	1	20 ohms; 10 W
214	Shunt for 250-mA ammeter	1	-
215	Ditto	1	-
216	Jack No. 3560	1	-
217	Ditto	1	-
218	Contactor	1	-

1	2	3	4
219	Contactor	1	-
220	Resistor, silit; installed if necessary	1	20 ohms; 10 W
221	Ditto	1	20 ohms; 10 W
222	Ditto	1	20 ohms; 5 W
	Unit No.4		
231	Inductance coil	1	$L_{max.}$ = 15 μH
232	Switch	1	-
233	Switch	1	-
234	Milliammeter M-52	1	For 1 mA
235	Capacitor KCO-5-500-A-10000	1	10000 pF; 500 V
236	Capacitor KCO-5-500-A-10000	1	10000 pF; 500 V
237	Capacitor КВКБ-11-47-II	12	Resultant capacitance 35 pF
238	Capacitor КВКБ-11-47-II КВКБ-14-27-II	2 2	Resultant capacitance 150 pF
239	Capacitor КВКБ-11-47-II	9	Resultant capacitance approx. 405 pF
240	Capacitor КВКБ-14-27-II	4	Resultant capacitance approx. 30 pF

1	2	3	4
241	Capacitor КВКБ-11-47-II КВКБ-14-27-II	4 4	Resultant capacitance approx. 75 pF
242	Capacitor КВКБ-11-47-II КВКБ-14-27-II	2 2	Resultant capacitance 150 pF
243	Capacitor КВКБ-11-47-II КВКБ-14-27-II	4 4	Resultant capacitance 300 pF
244	Capacitor КВКБ-10-56-II	10	Resultant capacitance 600 pF
245	Valve 6X6M	1	-
246	Transformer, high frequency	1	-
247	Ditto	1	-
248	Resistor BC-0.25-100 ±10%	4	100 ohms; 0.25 W, connected in parallel
249	Ditto BC-0.25-100 ±10%	4	100 ohms; 0.25 W, connected in parallel
250	Ditto BC-0.5-15 ±10%	1	15 kilohms; 0.5 W, selected during alignment
251	Neon lamp MH-3	1	-

1	2	3	4
	Unit No.5		
261	Switch	1	-
262	Valve 6Ж7	1	-
263	Device Б (crystal)	1	-
264	Capacitor, trimming	1	-
265	Choke	1	-
266	Thermostat winding	1	1600 ohms
267	Thermal fuse	1	Operating temperature 80°
268	Capacitor KCO-5-500-A-10000-III	1	10000 pF
269	Contact thermometer 60°	1	-
270	Relay PMУ-171.71.32	1	-
271	Capacitor KCO-5-500-A-7500-II	2	7500 pF, connected in parallel
272	Resistor BC-0.5-2.2 ±20%	1	2.2 kilohms; 0.5 W
273	Lamp, miniature	1	6.3 V; 0.28 A
274	Resistor BC-1.0-47 ±10%	1	47 kilohms; 1 W
275	Resistor, vitrified, type I	1	300 ohms
276	Resistor, vitrified, type I	1	400 ohms
277	Switch, two-pole	1	-
278	Choke, five-section	1	-
279	Capacitor KCO-4-500-Г-300-I	1	300 pF; 500 V
280	Ditto KCO-6-500-A-8200-II	1	8200 pF; 500 V

1	2	3	4
281	Capacitor	1	8200 pF; 500 V
282	Ditto	1	8200 pF; 500 V
283	Capacitor KCO-4-500-Г-51-I	1	51 pF; 500 V
284	Resistor BC-1.0-0.47 ±10%	1	470 kilohms; 1 W
285	Ditto BC-1.0-30 ±5%	1	30 kilohms; 1 W
286	Ditto BC-1.0-62 ±5%	1	62 kilohms; 1 W
287	Valve 6H7	1	-
288	Resistor BC-1.0-390 ±10%	1	390 kilohms; 1 W
289	Ditto BC-2.0-110 ±5%	1	110 kilohms; 2 W
290	Valve 6H7	1	-
291	Resistor BC-0.5-220 ±10%	1	220 kilohms; 0.5 W
292	Ditto BC-2.0-110 ±5%	1	110 kilohms; 2 W
293	Ditto BC-2.0-110 ±5%	1	110 kilohms; 2 W
294	Ditto BC-1.0-390 ±10%	1	390 kilohms; 1 W
295	Ditto BC-2.0-110 ±5%	1	110 kilohms; 2 W
296	Ditto BC-2.0-15 ±5%	1	15 kilohms; 2 W
297	Ditto BC-0.5-220 ±10%	1	220 kilohms; 0.5 W
298	Keying relay TPM-43A	1	1200 ohms; 5 mA
299	Capacitor KCO-4-1000-150-Г-1	1	150 pF; 1000 V
300	Valve П-50	1	-
301	Choke, four-section	1	-

1	2	3	4
302	Capacitor KCO-5-500-A-5100-II	1	5100 pF; 500 V
303	Ditto KCO-6-500-8200-III	1	8200 pF
304	Ditto KCO-6-500-8200-III	1	8200 pF
305	Resistor BC-2.0-62 ±5%	1	62 kilohms; 2 W
306	Ditto BC-2.0-39 ±5%	1	39 kilohms; 2 W
307	Keying relay TPM-43A	1	1200 ohms; 5 mA
308	Capacitor КБГ-И-200-0.02-III	1	0.02 μF; 200 V
309	Ditto КБГ-И-200-0.02-III	1	0.02 μF; 200 V
310	Ditto	1	0.02 μF; 200 V
311	Ditto	1	0.02 μF; 200 V
312	Ditto	1	0.02 μF; 200 V
313	Ditto	1	0.02 μF; 200 V
314	Ditto	1	0.02 μF; 200 V
315	Resistor BC-0.25-51 ±5%	1	51 ohms; 0.25 W
316	Ditto BC-1-1.5 ±10%	1	1500 ohms; 1 W
317	Ditto BC-1-560 ±10%	1	560 ohms; 1 W
318	Choke	1	-
319	Ditto	1	-
320	Ditto	1	-
321	Ditto	1	-
322	Push-button switch without cage	1	-
323	Resistor BC-2.0-10 ±5%	1	10000 ohms; 2 W

1	2	3	4
324	Condenser, trimming, ceramic	1	$C_{min.}$ = 4.5 pF $C_{max.}$ = 12.5 pF
325	Resistor BC-1.0-150 ±10%	1	150 ohms; 1 W
326	Ditto	1	150 ohms; 1 W
327	Ditto	1	150 ohms; 1 W
328	Relay PMY-171.71.32	1	-
329	Resistor BC-0.5-2200 ±20%	1	2.2 kilohms
329[1]	Ditto BC-0.5-2.2 ±20%	1	2.2 kilohms; 0.5 W
330[1]	Capacitor KCO-5-500-A-7500-II	2	7500 pF; 500 V, connected in parallel
330	Ditto	2	Ditto
	Transmitter frame		
331	Resistor, wire-wound	1	0.2 ohm
332	Ditto	1	0.2 ohm
333	Resistor, vitrified, type III-500	1	500 ohms
334	Ditto	1	500 ohms
335	Resistor, wire-wound	1	0.9 ohm
	Crystal heating unit (alternating current version)		
156	Thermal fuse	3	Operating temperature 80°

1	2	3	4
157	Heater element	1	160 ohms
158	Heater element	1	160 ohms
159	Ditto	1	160 ohms
160	Relay, type PMY-171.71.32	1	-
161	Thermal regulator 60°	1	-
162	Capacitor KCO-5-500-A-7500-II	1	7500 pF; 500 V
163	Resistor BC-0.5-2.2 ±10%	1	2.2 kilohms; 0.5 W
164	Resistor, vitrified, type 1-400	1	400 ohms
165	Ditto, type 1-300	1	300 ohms
166	Lamp	1	6.3 V; 0.28 A
167	Resistor, wire-wound	1	25 ohms
168	Toggle switch	1	-
169	Fuse, type A-43-2	2	For 2 A
170	Capacitor KCO-5-500-A-7500-II	2	7500 pF each; connected in parallel
171	Resistor BC-1.0-560 ±10%	1	560 ohms; 1 W
172	Relay, type PMY-171.71.32	1	-
173	Fuse, type A-43-2	1	For 2 A
174	Capacitor KCO-5-500-A-7500-II	2	7500 pF each; connected in parallel
175	Resistor BC-0.5-2.2 ±10%	1	2.2 kilohms, 0.5 W

1	2	3	4
	Heater of master oscillator circuit in unit No.1 (direct current version)		
55	Motor, 110 V D.C. type СЛ-261	1	-
56	Resistor,vitrified,type 1-1000	1	1000 ohms
57	Ditto, type 1-900	1	900 ohms only for 220 V mains voltage
58	Ditto, type 1	1	5000 ohms for 220 V; 2500 ohms for 110 V
59	Ditto, type 1-300	1	300 ohms
60	Ditto, type 1-300	1	300 ohms
61	Ditto, type 1	1	25 ohms for 220 V; 15 ohms for 110 V
62	Ditto, type 1-500	1	500 ohms
63	Heating element	1	225 ohms for 110 V 900 ohms for 220 V
64	Thermal fuse	1	Operating temperature 80^{0}
65	Contact thermometer 60^{0}	1	-
66	Lamp miniature	1	6.3 V; 0.28 A
67	Relay РМУ-171.71.32	1	400 ohms; 10 V
73	Capacitor КБГ-М-2-200-0.1-III	1	0.1 μF; 200 V
74	Ditto КБГ-М-2-400-0.25-III	1	0.25 μF; 400 V

1	2	3	4
75	Capacitor КБГ-М-1-400-0.25-III	1	0.25 μF; 400 V
76	Toggle switch, two-pole	1	-
82	Capacitor КСО-5-500-10000-III	1	10000 pF; 500 V
	Crystal heater unit No.5 (direct current version)		
260	Resistor, wire-wound	1	45 ohms for 110 V only
266	Thermostat winding	1	1600 ohms for 220 V; 400 ohms for 110 V
267	Thermal fuse	1	Operating temperature 80°
268	Capacitor КСО-5-500-10000-III	1	10000 pF
269	Contact thermometer 60°	1	-
270	Relay РМУ-171.71.32	1	
271	Capacitor КСО-5-500-А-7500-II	2	7500 pF; 500 V, connected in parallel
272	Resistor ВС-0.5-2.2 ±20%	1	2.2 kilohms; 0.5 W
273	Lamp, miniature	1	6.3 V; 0.28 A
276	Resistor, vitrified, type 1-300	1	300 ohms
275	Ditto, type 1-2500	1	2500 ohms only for 220 V

1	2	3	4
277	Toggle switch, two-pole	1	-
328	Vitrified resistor, type 1-2500	1	2500 ohms
329	Ditto BC-0.5-2200 ±20%	1	2.2 kilohms; 0.5 W
330	Capacitor KCO-5-500-A-7500-II	2	7500 pF; 500 V, connected in parallel
	Crystal heater unit (direct current version)		
156	Thermal fuse	3	Operating temperature 80°
157	Heater element	1	160 ohms for 220 V; 40 ohms for 110 V
158	Ditto	1	160 ohms for 220 V; 40 ohms for 110 V
159	Ditto	1	160 ohms for 220 V; 40 ohms for 110 V
160	Relay PMY-171.71.32	1	-
161	Contact thermometer 60°	1	-
162	Capacitor KCO-5-500-A-7500-II	2	7500 pF; 500 V, connected in parallel
163	Resistor BC-0.5-2.2 ±10%	1	2.2 kilohms, 0.5 W

1	2	3	4
164	Resistor, vitrified, type 1	1	5000 ohms for 220 V; 2500 ohms for 110 V
165	Resistor, vitrified, type 1	1	300 ohms
166	Lamp	1	6.3 V; 0.28 A
167	Resistor, wire-wound	1	25 ohms for 220 V; 10 ohms for 110 V
168	Toggle switch	1	-
169	Fuse A-43-2	2	For 2 A
170	Capacitor KCO-5-500-A-7500-II	2	7500 pF; 500 V, connected in parallel
171	Resistor BC-1.0-560 ±10%	1	560 ohms; 1 W

Appendix 8

LIST OF COMPONENTS OF REMOTE CONTROL EQUIPMENT

(See Appendix 13)

Circuit No.	Description and type	Quantity	Electrical data
1	2	3	4
	Modulator		
1	Microphone transformer	1	-
2	Valve 6A7	1	-
3	Capacitor КБГ-М1-400-0.25-III	1	0.25 μF; 400 V
4	Ditto КСО-5-500-А-4700-III	1	4700 pF; 500 V
5	Ditto КБГ-М1-400-0.05-III	1	0.05 μF; 400 V
6	Ditto КЭГ-1-В-50-$\frac{50}{\text{МК}}$-VI	1	50 μF; 50 V
7	Ditto КБГ-М1-200-01-III	1	0.1 μF; 200 V
8	Resistor ВС-0.25-1.5 ±10%	1	1500 ohms; 0.25 W
9	Ditto ВС-0.25-68 ±10%	1	68 kilohms; 0.25 W
10	Ditto ВС-0.5-560 ±10%	1	560 kilohms; 0.5 W
11	Ditto ВС-0.5-220 ±10%	1	220 kilohms; 0.5 W
12	Resistor, variable, type ОМЕГА 33-В-1	1	33 kilohms; 1 W
13	Resistor ВС-0.25-1 ±10%	1	1 megohm; 0.25 W
14	Ditto ВС-2-22 ±5%	1	22 kilohms; 2 W
15	Ditto ВС-0.25-680 ±10%	1	680 ohms; 0.25 W
16	Ditto ВС-0.5-2.2 ±20%	1	2.2 megohms; 0.5 W

1	2	3	4
17	Resistor, variable, type ОМЕГА 470-В-1	1	470 kilohms; 1 W
18	Capacitor КБГ-М1-200-0.25-III	1	0.25 μF; 200 V
19	Ditto КБГ-М2-600-0.1-III	1	0.1 μF; 600 V
20	Valve 6Ж8	1	-
21	Valve ГУ-50	1	-
22	Resistor ВС-0.25-22 ±10%	1	22 kilohms; 0.25 W
23	Ditto ВС-2-560 ±10%	1	560 ohms; 2 W
24	Capacitor КЭГ-1-В-50 - $\frac{50}{МК}$ - VI	1	50 μF; 50 V
25	Modulation transformer	1	-
26	Capacitor КСО-4-1000-А-1000-IV	1	1000 pF; 1000 V
27	Ditto КБГ-М2-600-0.1-III	1	0.1 μF; 600 V
28	Resistor ВС-0.5-51 ±20%	1	51 kilohms; 0.5 W, selected during alignment
29	Ditto ВС-1-22 ±5%	1	22 kilohms; 1 W
30	Ditto ВС-1-22 ±5%	1	22 kilohms; 1 W
31	Ditto ВС-0.5-1 ±5%	1	1 kilohm; 0.5 W
32	Ditto ВС-0.5-1 ±5%	1	1 kilohm; 0.5 W
33	Resistor, variable, type ОМЕГА 470-А-2	1	470 kilohms; 2 W
34	Milliammeter М-52 (modulation depth meter)	1	For 1 mA; graduated M=60, 70, 80%

1	2	3	4
35	Valve 6X6M	1	-
36	Valve 6Ж8	1	-
37	Transformer, tone generator	1	-
38	Resistor BC-0.25-22 ±10%	1	22 kilohms; 0.25 W
39	Resistor BC-0.5-100 ±10%	1	100 kilohms; 0.5 W
40	Resistor BC-0.25-5100 ±5%	1	5100 ohms; 0.25 W
41	Ditto BC-0.25-560 ±10%	1	560 kilohms; 0.25 W
42	Resistor, variable, type ОМЕГА 470-B-1	1	470 kilohms; 0.5 W
43	Capacitor KCO-5-500-B-1800-1	1	1800 pF; 500 V
44	Capacitor КБГ -M1-400-0.05-III	1	0.05 μF; 400 V
45	Ditto КБГ-M1-200-01-III	1	0.1 μF; 200 V
46	Ditto KCO-5-500-A-4700-III	1	4700 pF; 500 V
47	Capacitor KCO-5-500-B-4700-III	1	4700 pF; 500 V
48	Valve 6Ж8	1	-
49	Checking transformer	1	-
50	Resistor BC-0.25-1 ±20%	1	1 megohm; 0.25 W
51	Resistor BC-0.5-1.0 ±20%	1	1 megohm; 0.5 W
52	Ditto BC-0.25-1.2 ±10%	1	1200 ohms; 0.25 W
53	Ditto BC-0.25-100 ±20%	1	100 kilohms; 0.25 W
54	Capacitor KCO-8-1000-A-10000-III	1	10000 pF; 1000 V
55	Ditto КБГ-M1-400-0.1-III	1	0.1 μF; 400 V
56	Valve 6X6M	1	-

1	2	3	4
57	Resistor BC-0.25-220 ±20%	1	220 kilohms; 0.25 W
58	Resistor, variable, type ОМЕГА 470-А-2	1	470 kilohms; 2 W
59	Ditto BC-0.25-560 ±10%	1	560 kilohms; 0.25 W
60	Ditto BC-0.25-68 ±10%	1	68 kilohms; 0.25 W
61	Ditto BC-0.25-560 ±10%	1	560 kilohms; 0.25 W
62	Ditto BC-0.5-1.5 ±10%	1	1.5 kilohms; 0.5 W
63	Ditto BC-1-560 ±10%	1	560 ohms; 1 W
64	Relay ТРМ-43А	1	1200 ohms; 5 mA
65	Resistor BC-1-560 ±10%	1	560 ohms; 1 W
66	Capacitor КБГ-М1-400-0.25-III	1	0.25 μF; 400 V
67	Capacitor КЭГ-1-В-20 - $\frac{50}{\text{МК}}$ - VI	1	50 μF; 20 V
	Control unit		
75	Heater push-buttons START (ПУСК) and STOP (СТОП)	1	-
76	Relay, type РМУ-171.73.32	1	-
77	Function switch	1	-
78	Filter choke	1	-
79	Filter choke	1	-
80	Capacitor КЭГ-1-В-50 - $\frac{20}{\text{МК}}$ - VI	1	50 μF; 50 V

1	2	3	4
81	Capacitor КЭГ-1-В-50 - $\frac{50}{\text{МК}}$ - VI	1	50 μF; 50 V
82	Potentiometer	1	4x2500 ohms
83	Power regulating switch	1	-
84	Call push-button	1	-
85	Switchboard lamp	1	24 V
86	Resistor ВС-1-560 ±10%	1	560 ohms; 1 W
87	Capacitor КЭГ-1-В-50 - $\frac{50}{\text{МК}}$ - VI	1	50 μF; 50 V
88	Transformer	1	-
89	Handset, МТК-2	1	-
90	Relay, type РМУ-171.73.32	1	-
92	Semi-duplex toggle switch	1	-
93	Relay ТРМ-43А	1	1200 ohms; 5 mA
94	Resistor ВС-1.0-1.5 ±10%	1	1500 ohms; 1 W
95	Ditto ВС-1.0-560 ±10%	1	560 ohms; 1 W
96	Toggle switch	2	Ganged
97	Signal lamp, red	1	26 V; 5 W
98	Signal lamp, green	1	26 V; 5 W
99	Telegraph key	1	-
100	Relay РМУ-171.91.87	1	-
101	Resistor, series	1	30 ohms
102	Ditto	1	30 ohms
103	Potentiometer	1	2500 ohms

1	2	3	4
104	Resistor, vitrified, type IV	1	2000 ohms
105	Resistor, variable, wire-wound	1	-
	Radio operator's post		
111	Heater push-buttons START and STOP	1	-
112	Signal lamp, red	1	26 V; 5 W
113	Signal lamp, green	1	26 V; 5 W
114	Toggle switch	2	Ganged
115	Monitoring toggle switch	1	-
116	Handset, MTK-2	1	-
118	Relay TPM-43A	1	1200 ohms; 5 mA
119	Transformer	1	-
120	Coil push-button	1	-
121	Switchboard lamp	1	24 V
122	Capacitor КЭГ-1-В-50 - $\frac{50}{\text{МК}}$ - VI	1	50 μF; 50 V
123	Resistor BC-1-560 ±10%	1	560 ohms; 1 W
124	Ditto BC-1-1.5 ±10%	1	1500 ohms ±10%; 1 W
125	Ditto BC-1-560 ±10%	1	560 ohms ±10%; 1 W
127	Semi-duplex toggle switch	1	-
128	Telegraph key	1	-
129	Resistor, series	1	30 ohms
130	Ditto	1	30 ohms

1	2	3	4
	Remote communication post		
135	Push-buttons START and STOP	1	-
136	Signal lamp, red	1	26 V; 5 W
137	Signal lamp, green	1	6 V; 5 W
138	Toggle switch	2	Ganged
139	Handset, MTK-2	1	-
140	Additional telephone	1	-
141	Relay РМУ-171.73.32	1	-
142	Transformer	1	-
143	Call push-button	1	-
144	Switchboard lamp	1	24 V
145	Capacitor КЭГ-1-В-50 - $\frac{50}{\text{МК}}$ - VI	1	50 μF; 50 V
146	Resistor ВС-1-560 ±10%	1	560 ohms; 1 W
147	Telegraph key jack	1	-
151	Resistor, series	1	30 ohms
152	Ditto	1	30 ohms
	Amplifier with dynamic		
219	Capacitor КБГ-МП-2В-600- $\frac{0.25}{\text{И}}$-III	1	0.25 μF; 600 V
221	Resistor, variable, type ОМЕГА 33-В-1	1	33 kilohms; 1 W

1	2	3	4
222	Valve 6Ж8	1	-
223	Resistor BC-0.25-1.5 ±10%	1	1500 ohms; 0.25 W
224	Capacitor КЭГ-1-2В-12 - $\frac{100}{МИ}$ - VI	1	100 µF; 12 V
225	Ditto КБГ-М1-200-0.05-III	1	0.5 µF; 200 V
226	Resistor BC-0.25-1000 ±10%	1	1000 kilohms; 0.25 W
227	Capacitor КЭГ-1-2В-150 - $\frac{50}{МИ}$ - VI	1	50 µF; 150 V
228	Resistor BC-0.25-270 ±10%	1	270 kilohms; 0.25 W
229	Ditto BC-0.25-560 ±10%	1	560 kilohms; 0.25 W
230	Capacitor KCO-5-500-A-10000-III	1	10000 pF; 500 V
231	Valve 30П1М	1	-
232	Capacitor КЭГ-1-2Н-12 - $\frac{100}{МИ}$ - VI	1	100 µF; 12 V
233	Resistor BC-1-150 ±10%	1	150 ohms; 1 W
234	Ditto BC-2-1.2 ±10%	1	1200 ohms; 2 W
235	Output transformer	1	-
236	Input transformer	1	-
237	Fuse A-43-2	2	2 A
238	Capacitor КЭГ-1-2В-150 - $\frac{50}{МИ}$ - VI	1	50 µF; 150 V
239	Switch	1	-

1	2	3	4
240	Selenium stack	2	-
241	Switch	1	-
242	Resistor, vitrified, type IV-300	1	300 ohms
243	Signal lamp	1	6.3 V; 0.28 A
244	Resistor BC-1.0-68 ±10%	2	68 ohms, connected in parallel
245	Capacitor KCO-2-500-A-200-III	1	200 pF; 500 V
246	Toggle switch	1	-
248	Resistor, vitrified, type IV-300	1	300 ohms
249	Dynamic ЗГД-2М	1	-

Appendix 9

LIST OF COMPONENTS FOR BC-1 RECTIFIER

(See Appendix 14)

Circuit No.	Description and type	Quantity	Electrical data
1	2	3	4
501	Shipboard switch	1	-
502	Fuse panel ПР-1, ПР-2 and ПР-3	1	-
503	Neon lamp MH-5	1	-
504	Ditto	1	-
505	Ditto	1	-
506	OVERHEAT (ПЕРЕГРЕВ) dial lamp	1	26 V; 0.15 A
507	OVERLOAD (ПЕРЕГРУЗКА) dial lamp	1	26 V; 0.15 A
508	Emergency switch (toggle switch)	1	220 V; 1 A
509	Switch panel of rectifier B-5	1	-
510	Current transformer	1	-
511	Overload relay PMУ-171.40.12 for rectifier B-5	1	-
512	Screen grid bias relay PMУ-171.71.47	1	-
514	Selenium stacks BC-35-35 for rectifier B-4	2	-
515	Electromagnetic three-pole contactor KM-1	1	-

1	2	3	4
516	Electrolytic capacitor КЭГ-2	3	20 μF; 450 V
517	Filter choke	1	12 H
518	Transformer	1	220/248/295 V
519	Filter choke	1	2.5 H
520	Paper-oil capacitor КБГ-МН	3	600 V; 6 μF
521	Heater transformer	1	220/6.3/6.3 V
522	Three-phase transformer for rectifier B-5	1	220/380/600 V
524	Bimetal overheat relay	1	-
526	Three-phase transformer for rectifier B-6	1	220/2500 V
527	Switch panel of transformer 526	1	-
528	Electromagnetic contactor KM-1	1	-
529	High-tension switch	1	-
533	Filter choke	1	1.2 H
534	Ditto	1	1.2 H
535	Paper-oil capacitor КБГ-МН	12	2 μF; 1500 V
536	Delay relay РМУ-171.71.32	1	-
537	Overload relay РМУ-171.40.12 for rectifier B-6	1	-
538	Heater transformer	1	220/15 V
539	Dial lamp	1	26 V; 5 W
541	Fuse unit with signal lamps	1	-

1	2	3	4
542	Push-button switch	1	-
543	Voltmeter M-41	1	50 V
544	Ammeter M-41	1	20 A
545	Selenium rectifier for ammeter	1	-
546	Electrolytic capacitor КЭГ-2	3	20 μF; 450 V
547	Panel with three fuses ПР-4, ПР-5 and ПР-6	1	-
548	Transformer switch panel for rectifier B-1	1	-
549	Panel of electronic stabilizer and barretter	1	-
550	Electromagnetic contactor	1	-
551	Electrolytic capacitor КЭГ-2	3	20 μF; 450 V
552	Selenium stack BC-100-34 of rectifier B-1	1	-
553	Selenium stack BC-35-35 of rectifier B-3	2	-
554	Selenium stack BC-35-35 of rectifier B-2	2	-
555	Filter choke	1	-
556	Transformer of rectifier B-3	1	-
557	Choke of rectifier B-2	1	-
558	Transformer of rectifier B-2	1	-
559	Heater transformer	1	220/27/6.5 V

1	2	3	4
560	Semi-variable vitrified ballast resistor, type III-100	1	100 ohms
561	Three-phase transformer of rectifier B-1	1	220/24/13.5 V
562	Copper-oxide rectifier ВКИ-1	1	-
563	Selenium stacks of rectifier B-5	12	-
564	Selenium stacks of rectifier B-6	18	-
565	Selenium stacks of rectifier B-6	18	-
566	Resistor, vitrified, type V	2	20 kilohms, connected in series
567	Resistor, vitrified, type IV	1	5 kilohms
568	Ditto	1	10 kilohms
569	Ditto	1	10 kilohms
570	Dial lamp TUNING (НАСТРОЙКА)	1	26 V; 5 W
571	Switch (toggle switch) TUNING (НАСТРОЙКА)	1	220 V; 1 A
580	Resistor, vitrified, type III	1	50 ohms
581	Socket	1	220 V
582	Resistor, wire-wound	1	1400 ohms
583	Ditto	1	1400 ohms
$Л_2$	Signal lamp MH-5	6	-
$Л_3$	Barretter 1Б10-17	1	-

1	2	3	4
$Л_{4}$	Valve 6B4	1	-
$Л_{9}$	Stabilivolt 150-C5-30	1	-
$Л_{10}$	Double triode 6H7C	1	-
$Л_{11}$	Valve 6Ж8	1	-
$Л_{12}$	Stabilivolt 75-C5-30	1	-
R_{1}	Resistor BC-0.5-100	3	100 kilohms; 0.5 W
R_{2}	Ditto	6	100 kilohms; 0.5 W
R_{3}	Resistor BC-1-270	1	270 kilohms; 1 W
R_{5}	Resistor, wire-wound	1	0.6 ohm
R_{6}	Resistor BC-2-33	1	33 kilohms; 2 W
R_{7}	Resistor, semi-variable, vitrified, type III-50	1	50 ohms
R_{13}	Resistor, wire-wound	1	58.8 kilohms
R_{14}	Ditto	1	Ditto
R_{15}	Ditto	1	Ditto
R_{16}	Ditto	1	Ditto
R_{17}	Ditto	1	Ditto
R_{18}	Resistor, wire-wound	1	5870 ohms
R_{19}	Ditto	1	26400 ohms
R_{20}	Ditto	1	26400 ohms
R_{21}	Ditto	1	1.1 ohms

1	2	3	4
R_{22}	Resistor, wire-wound	1	1.1 ohms
R_{23}	Resistor 510, 915 or 1830 ohms	1	-
R_{24}	Resistor BC-0.5-510	1	510 kilohms; 0.5 W
R_{25}	Ditto BC-0.5-100	1	100 kilohms; 0.5 W
R_{26}	Ditto BC-0.5-100	1	100 kilohms; 0.5 W
R_{27}	Ditto BC-1-270	1	270 kilohms; 1 W
R_{28}	Resistor BC-0.5-48	1	48 kilohms; 0.5 W
R_{29}	Dropping resistor	1	50 ohms
C_1	Capacitor КБГ-И	1	400 V; 0.025 μF
C_2	Ditto	1	400 V; 0.025 μF
C_3	Ditto	1	400 V; 0.025 μF
Пр-1	Fuse ПД-I	1	For 10 A
Пр-2	Ditto	1	For 10 A
Пр-3	Fuse ПД-I	1	For 10 A
Пр-4	Fuse НД-II	1	For 6 A
Пр-5	Ditto	1	For 6 A
Пр-6	Ditto	1	For 6 A
Пр-7	Fuse ПК-43	1	For 0.5 A
Пр-8	Ditto	1	For 0.5 A
Пр-9	Ditto	1	For 5 A
Пр-10	Ditto	1	For 0.5 A
Пр-11	Ditto	1	For 0.5 A
Пр-12	Ditto	1	For 0.5 A

Appendix 10

LIST OF COMPONENTS OF ПТ-5 CONVERTER WITH CONTROL EQUIPMENT

(See Appendix 15)

Circuit No.	Description and type	Quantity	Electrical data
1	2	3	4
184	Supply switchboard (power switchboard)	1	1
177	Voltmeter ПМ-70 with external series resistor	1	For 300 V
178	Ammeter ПМ-70 with external shunt	1	100 A for 220 V; 200 A for 110 V
179	Fuse A-43	2	3 A for 220 V; 5 A for 110 V
180	Fuse	2	60 A for 220 V; 100 A for 110 V
181	Fuse A-43	2	1 A for 220 V; 2 A for 110 V
182	Signal lamp	1	26 V; 5 W
183	Ditto	1	26 V; 5 W
185	Supply switch	1	-
186	Push-buttons START (ПУСК) and STOP (СТОП)	1	-

1	2	3	4
187	Capacitor ВЗК-153	4	0.5 μF; 220 V
202	Resistor, vitrified, type IV	1	1000 ohms for 220 V; 500 ohms for 110 V
188	Starting station, КРП-5	1	-
189	Converter ПТ-5	1	-
190	Unit for regulating voltage of generator БРКТ-5	1	-
191	Unit for regulating voltage of generator БРШТ-5	1	-
192	Carbon voltage regulator of РУН-121 generator	1	-
193	Selenium rectifier ВС-255	1	-
194	Rheostat ВС-240, adjustable	1	-
195	Exciter regulator РВ-5212, manual	1	-

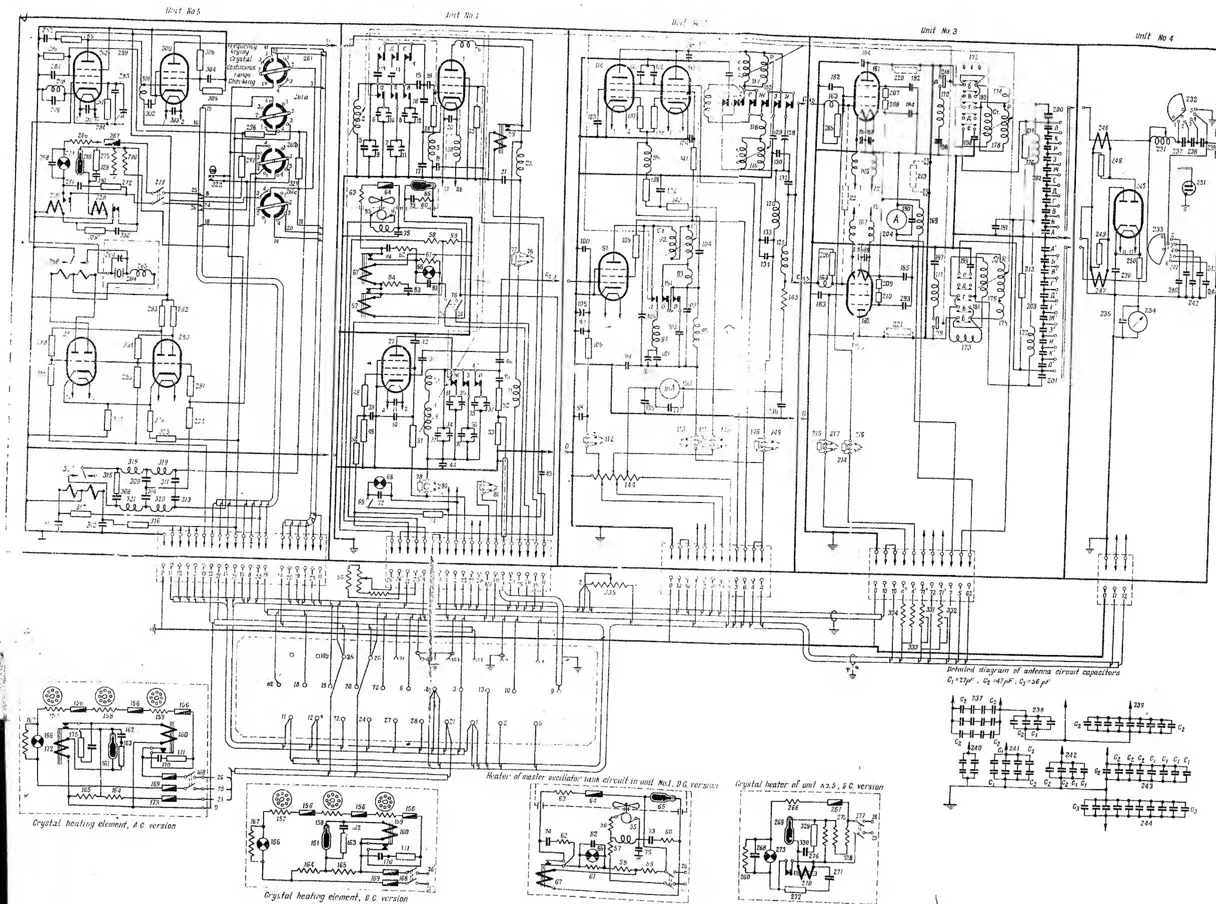
Appendix 11

LIST OF COMPONENTS OF П-7.2 CONVERTER WITH CONTROL EQUIPMENT

(See Appendix 16)

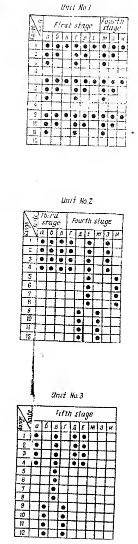
Circuit No.	Description and type	Quantity	Electrical data
1	2	3	4
184	Supply switchboard	1	-
177	Voltmeter ПМ-70 with external series resistor	1	For 300 V
178	Ammeter ПМ-70 with external shunt	1	100 A for 220 V; 200 A for 110 V
179	Fuse A-43	2	3 A for 220 V; 6 A for 110 V
180	Fuse	2	60 A for 220 V; 100 A for 110 V
181	Fuse A-43	2	1 A for 220 V; 2 A for 110 V
182	Signal lamp	1	26 V; 5 W
183	Ditto	1	26 V; 5 W
185	Supply switch	1	-
186	Push-buttons START (ПУСК) and STOP (СТОП)	1	-
187	Capacitor БЗК-153	4	0.5 μF; 220 V

1	2	3	4
202	Resistor, vitrified, type IV	1	1000 ohms for 220 V; 500 ohms for 110 V
195	Converter П-7.2	1	-
190	Capacitor B3K-153	1	0.5 μF; 220 V
191	Ditto	1	0.5 μF; 220 V
192	Ditto	3	0.5 μF; 220 V
193	Capacitor B3K-253	1	0.5 μF; 220 V
194	Ditto	1	0.5 μF; 220 V
196	Three-phase current transformer	1	-
198	Selenium rectifier	1	-
199	Filter choke	1	-
200	Exciter regulator P3B-21A	1	-
201	Automatic control station (starter) CMП-2001-21A1/22A2	1	-
208	Capacitor B3K-253	1	In one housing
209	Ditto	1	



Circuit Diagram of the KB-1 Transmitter

Switch positions according to range



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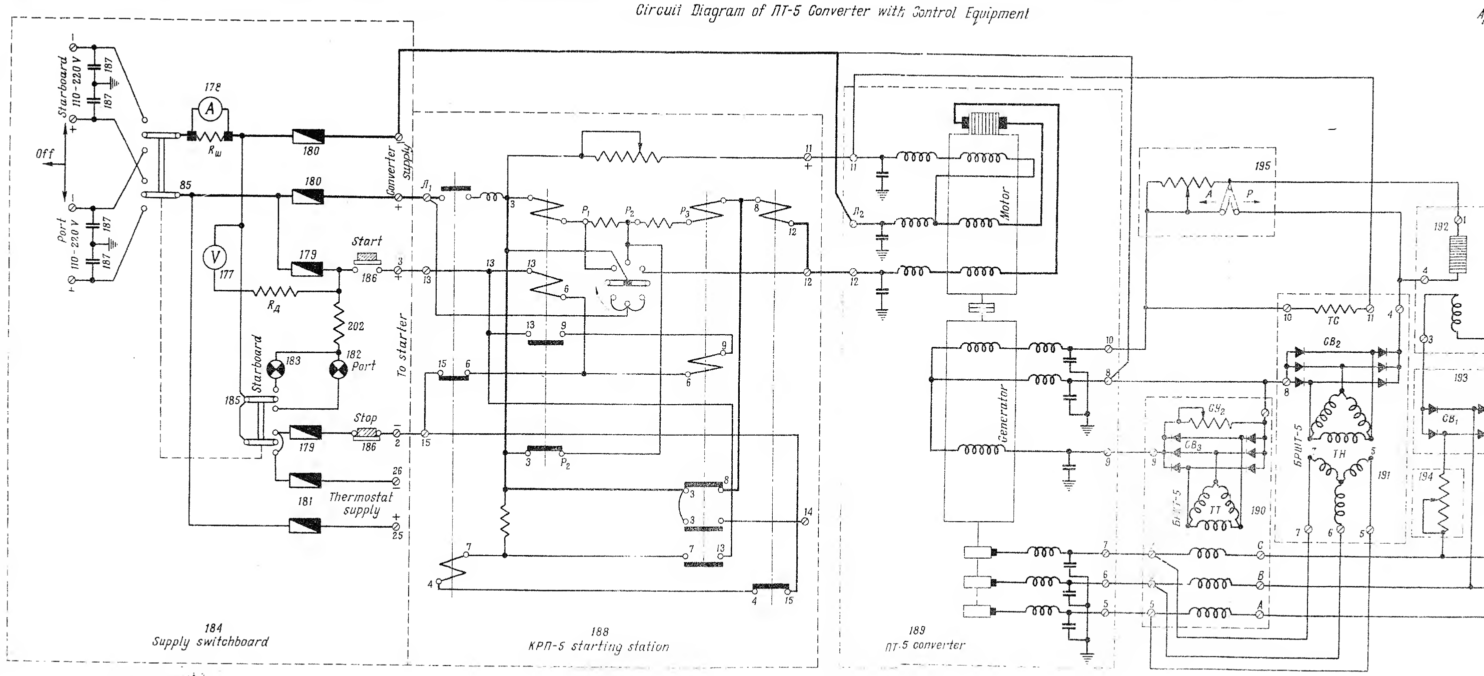
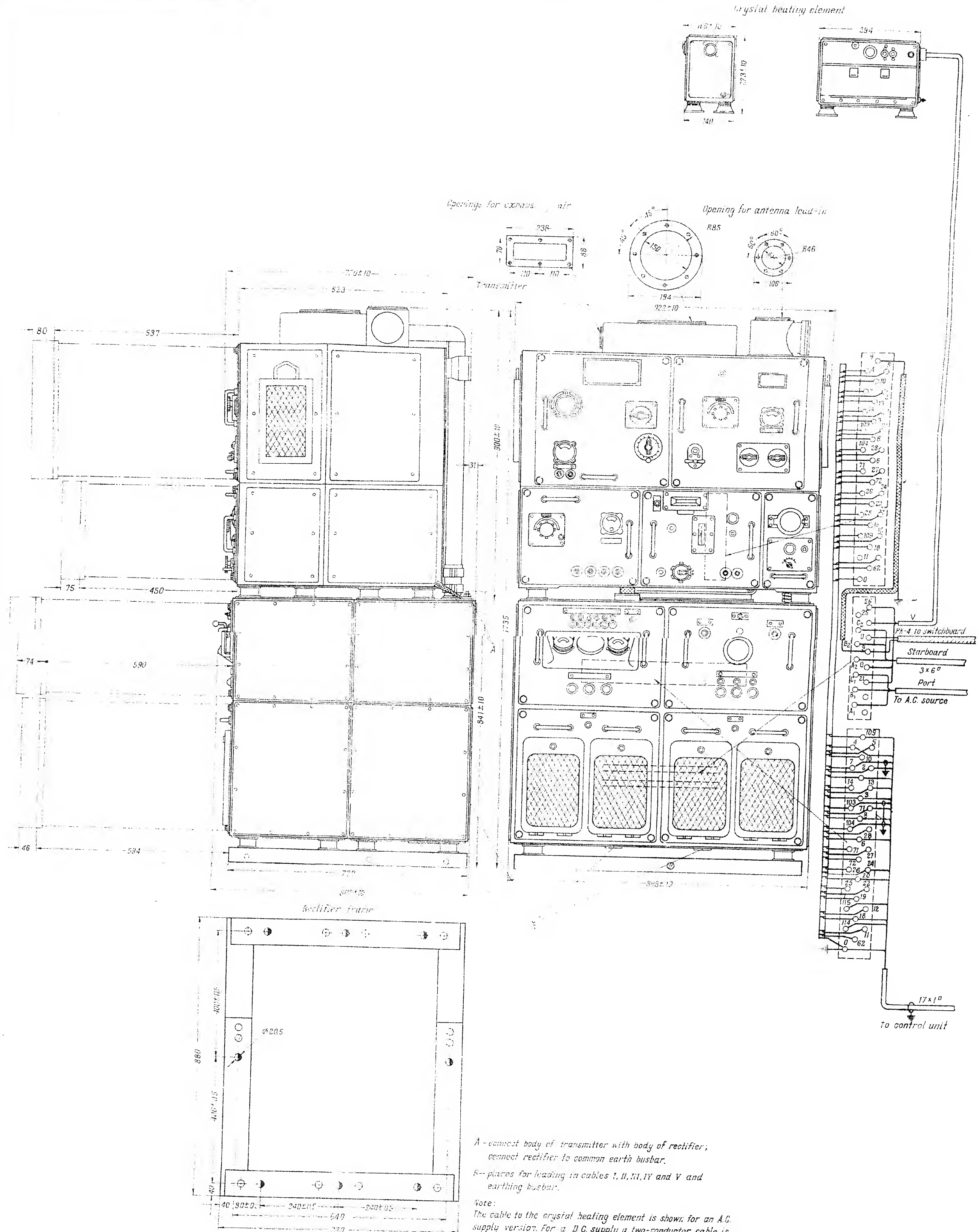
Circuit Diagram of ПТ-5 Converter with Control Equipment



...and Installation Diagram of KB-1 Transmitter and BC-1 Rectifier Assembly



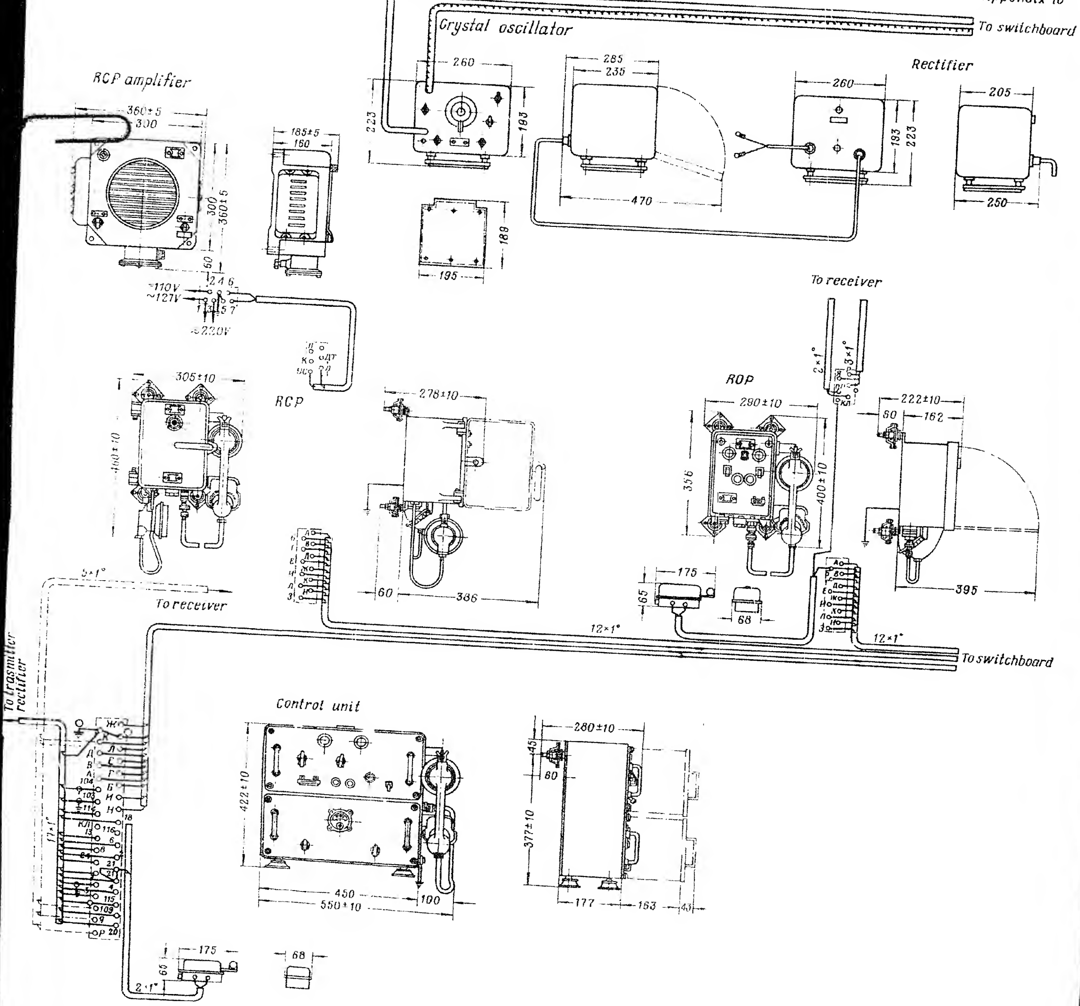
A - connect body of transmitter with body of rectifier; connect rectifier to common earth busbar.

B - places for leading in cables I, II, III, IY and V and earthing busbar.

Note:
The cable to the crystal heating element is shown for an A.C. supply version. For a D.C. supply a two-conductor cable is used, which is connected to terminals 25 and 26

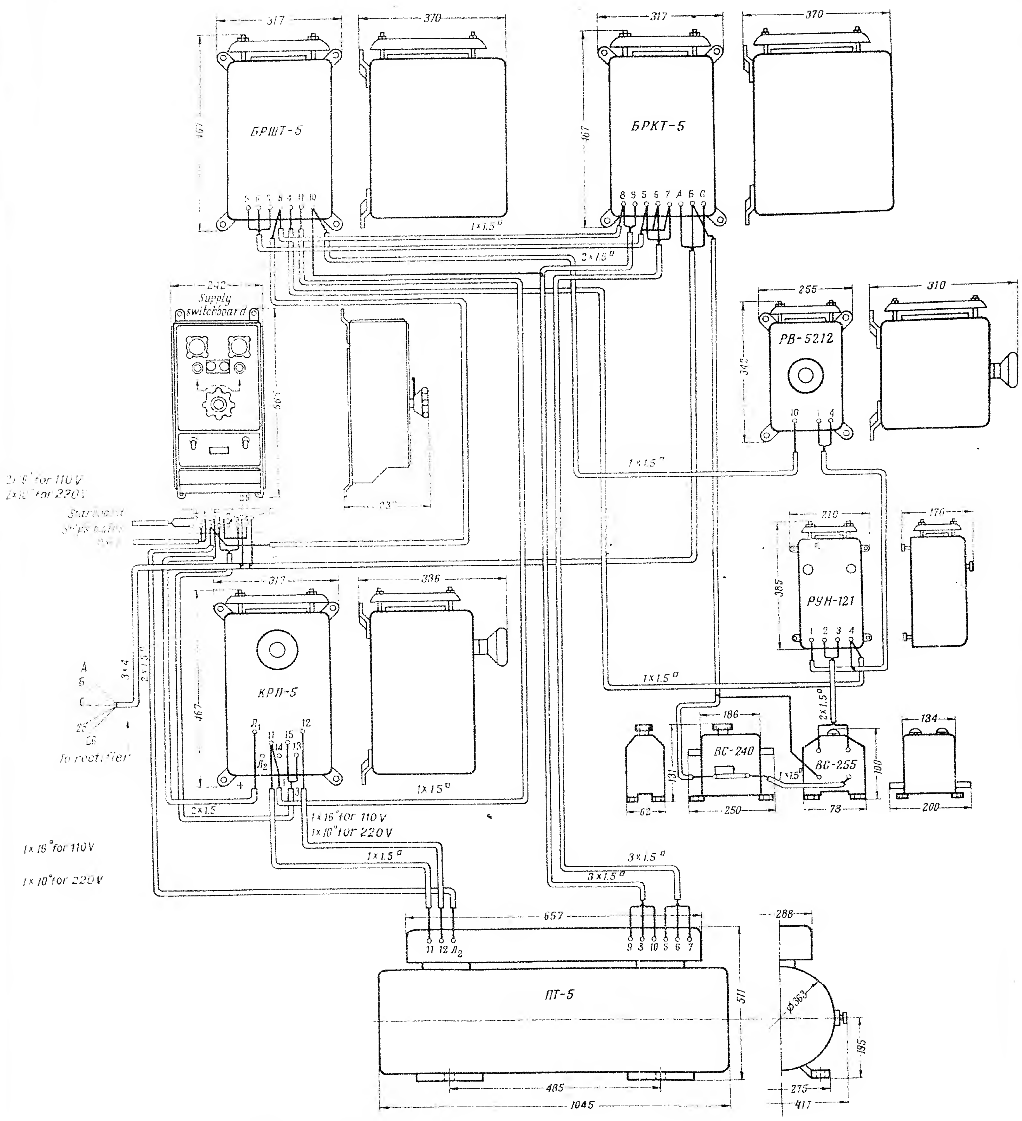
Wiring and Installation Diagram of Remote Control Equipment

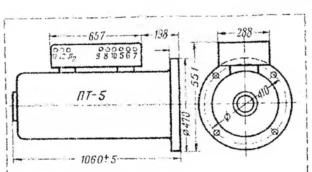
Appendix 18



Appendix 19

Wiring and Installation Diagram of Power Unit with ПТ-5 Converter



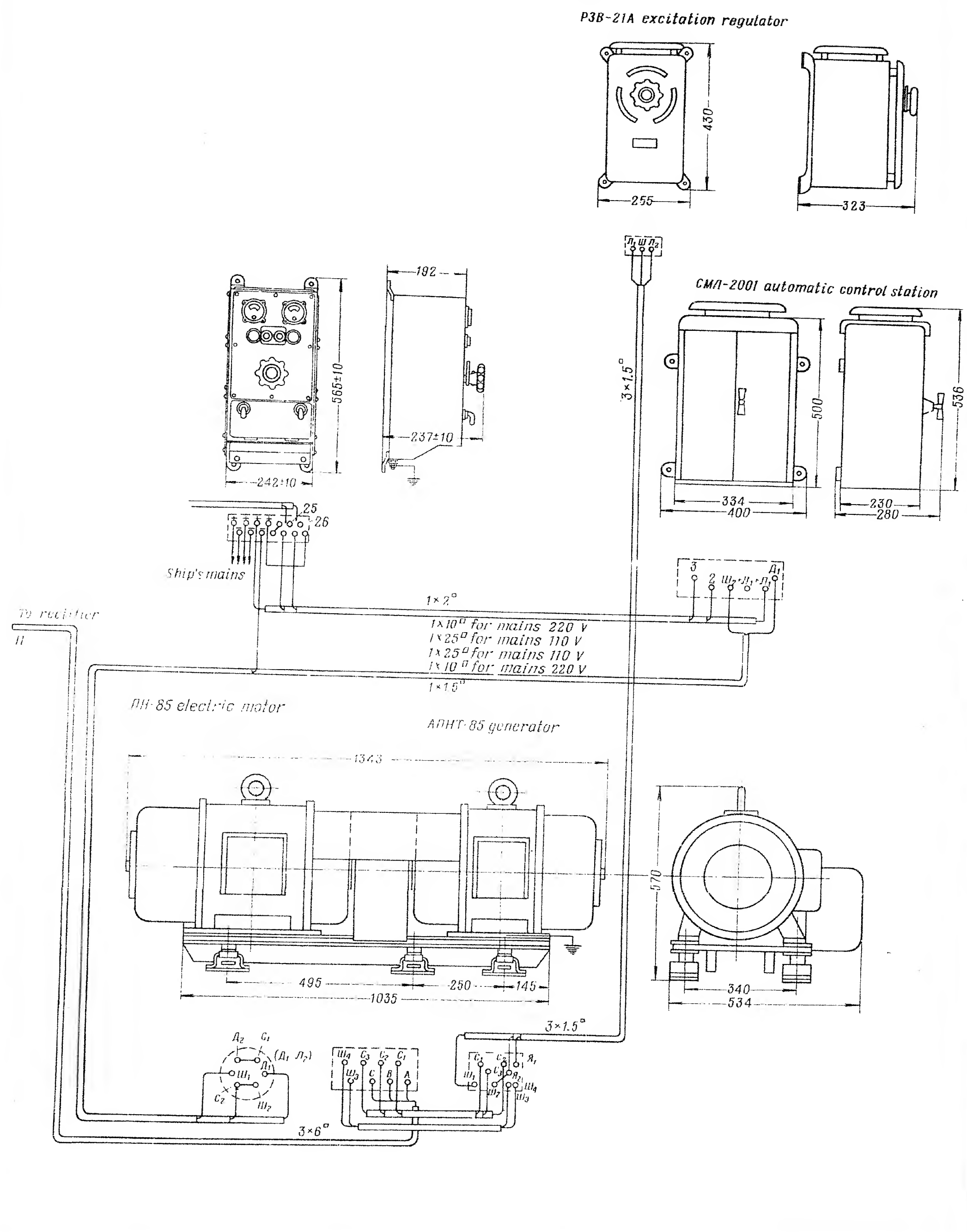


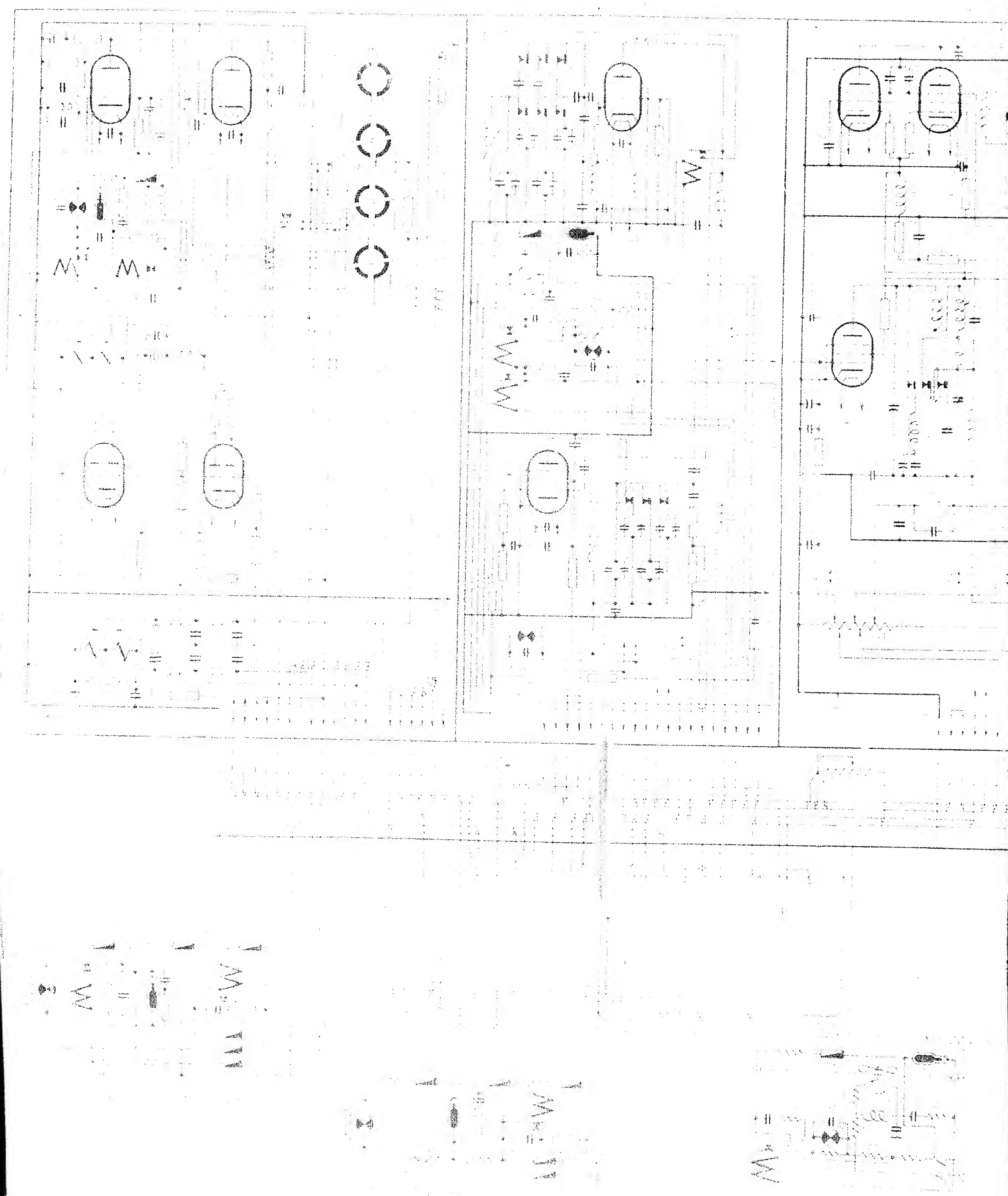
ПТ-5 converter

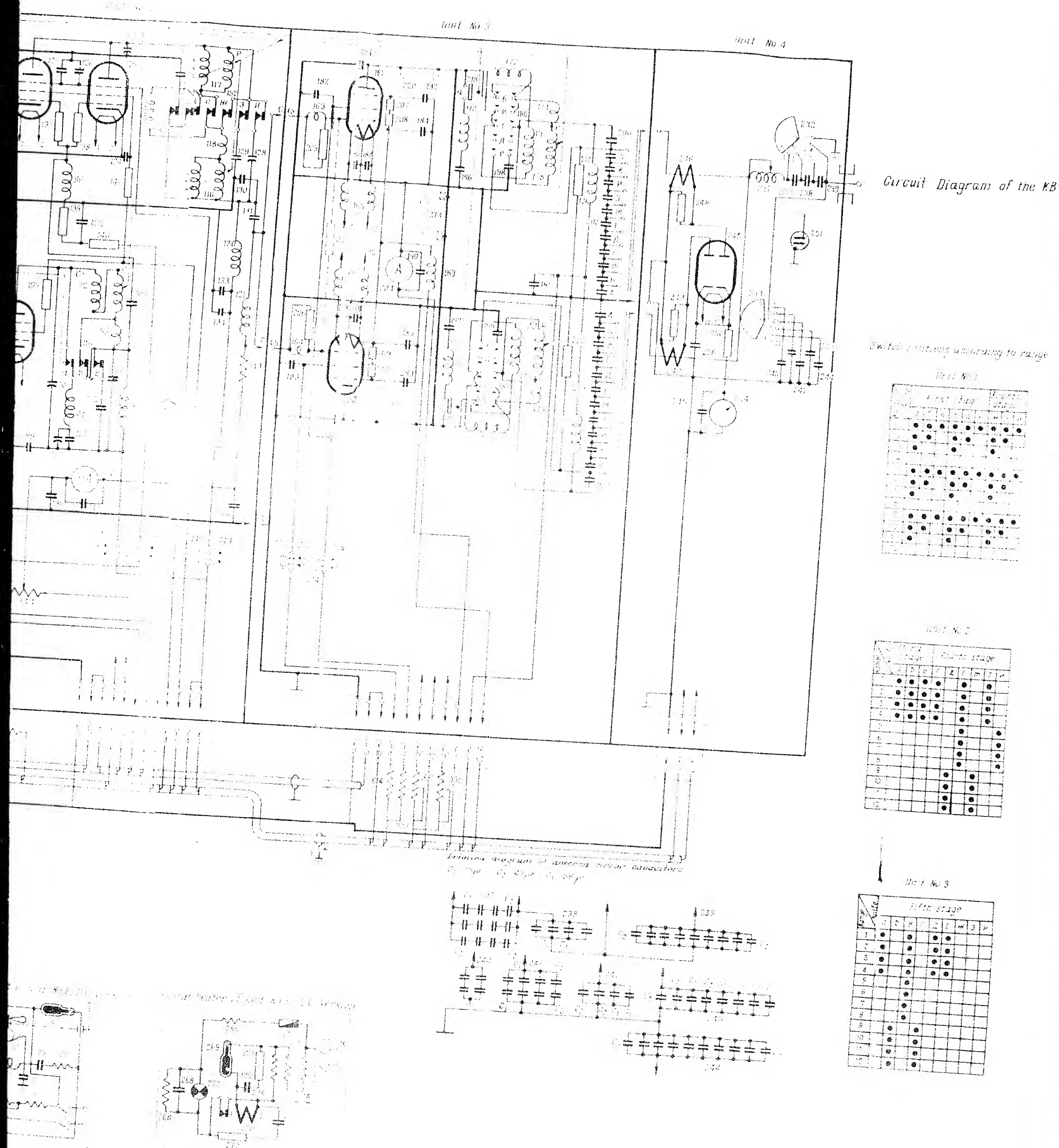
Note:
In some radio stations the regulating units БРШТ-5 and БРКТ-5 are combined in the single unit БРПТ-5

Wiring and Installation Diagram of Power Unit with П-7.2 Converter

Appendix 20

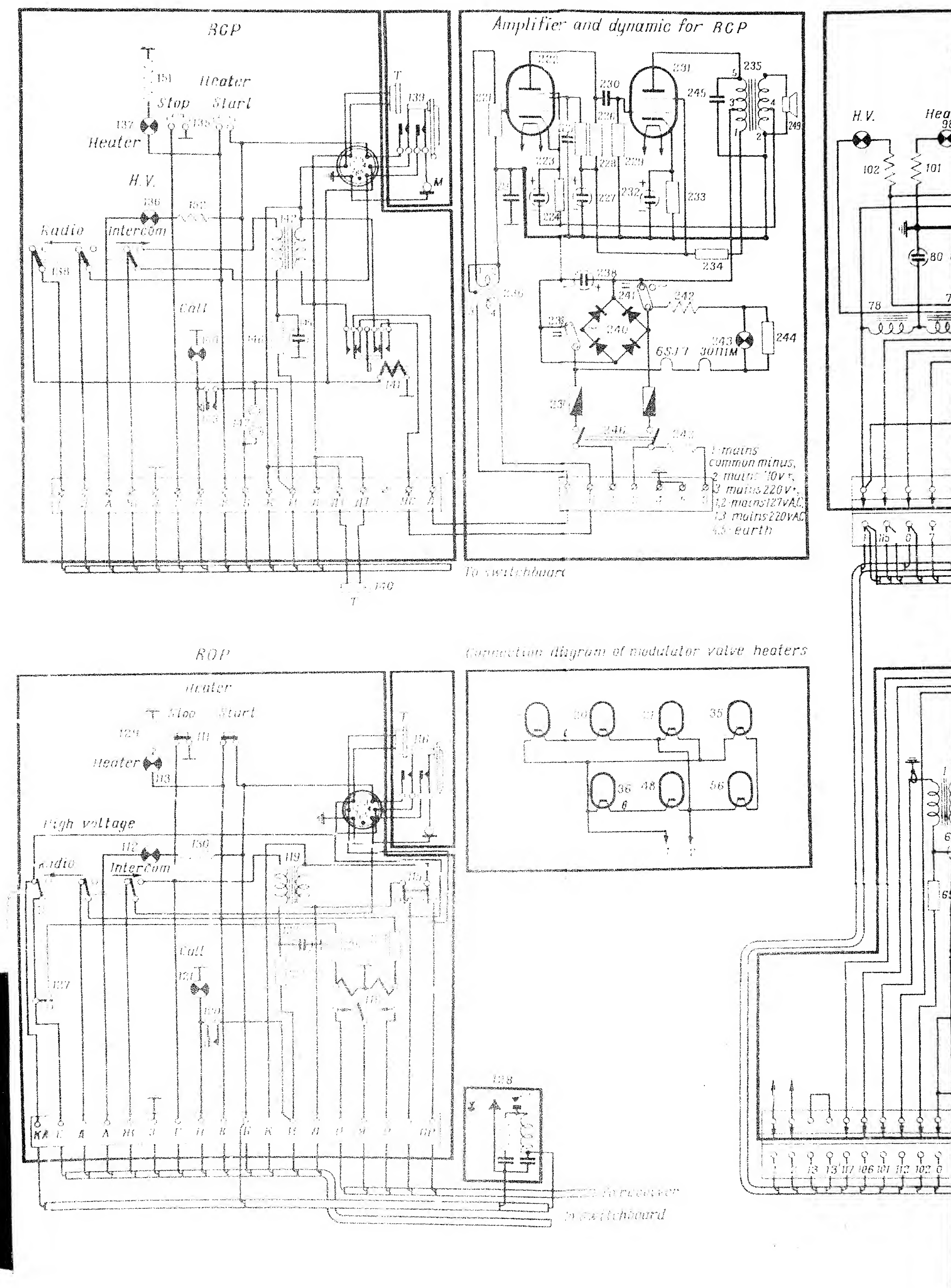




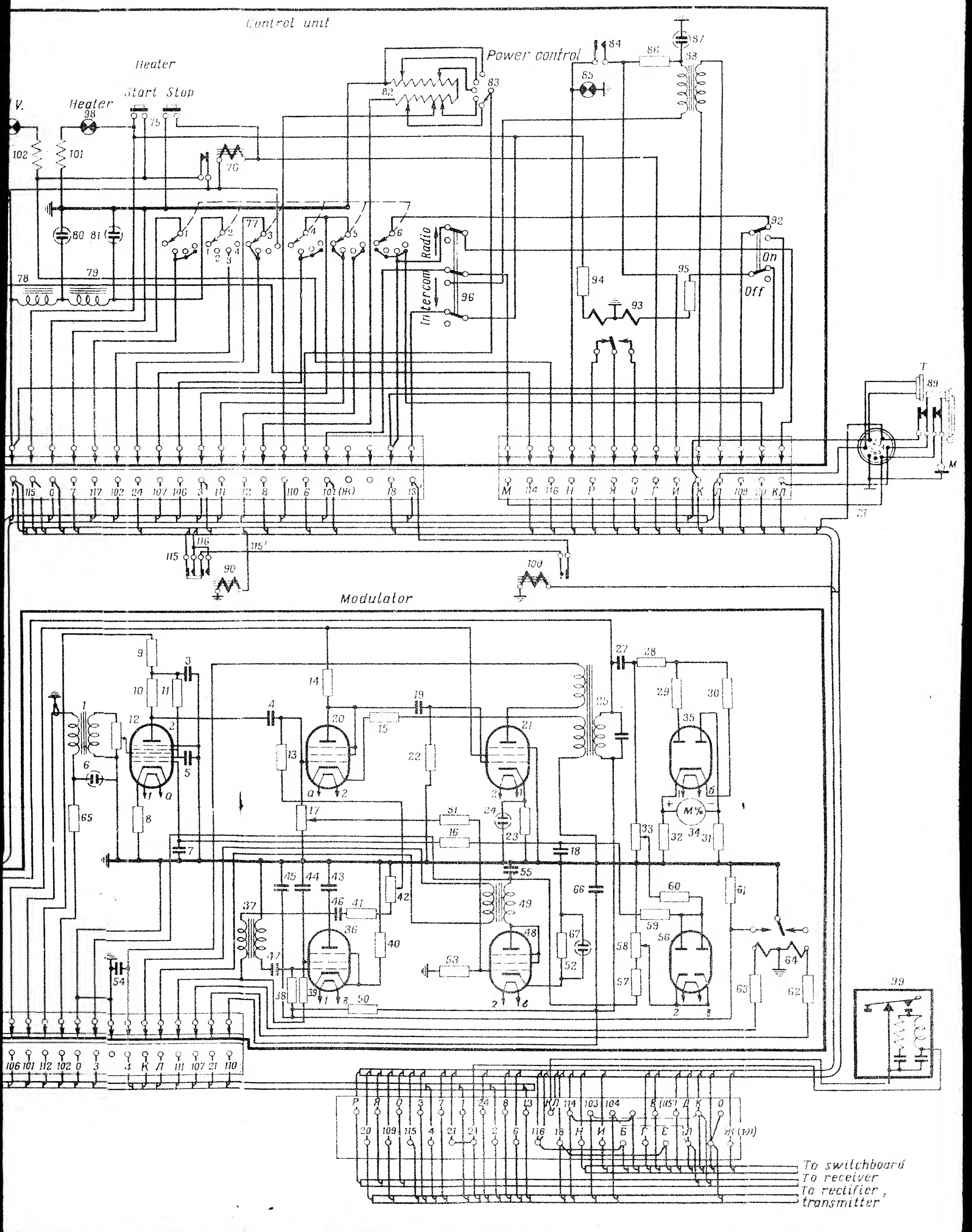


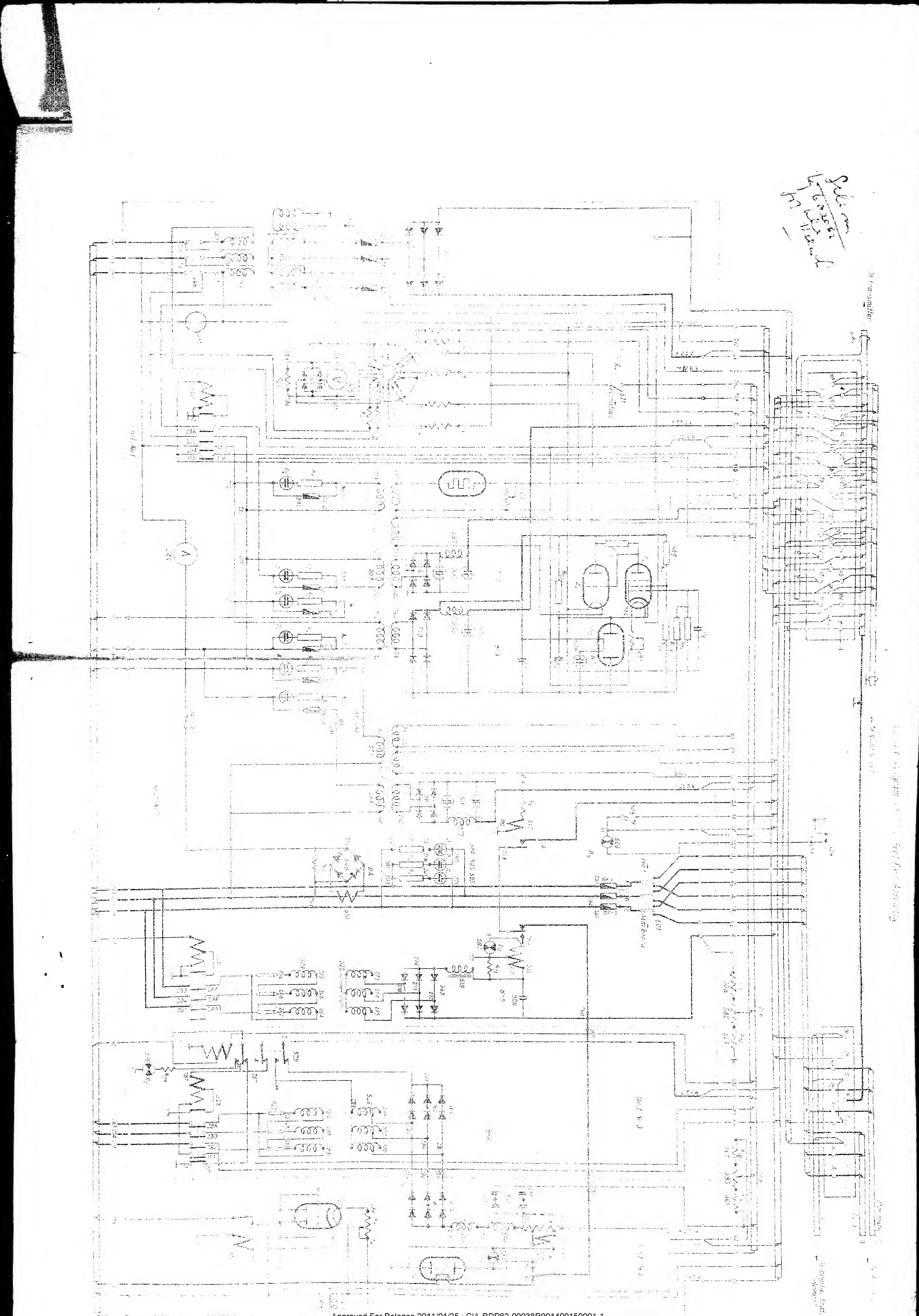
Circuit Diagram of the KB-1

Circuit Diagram of Remote Control

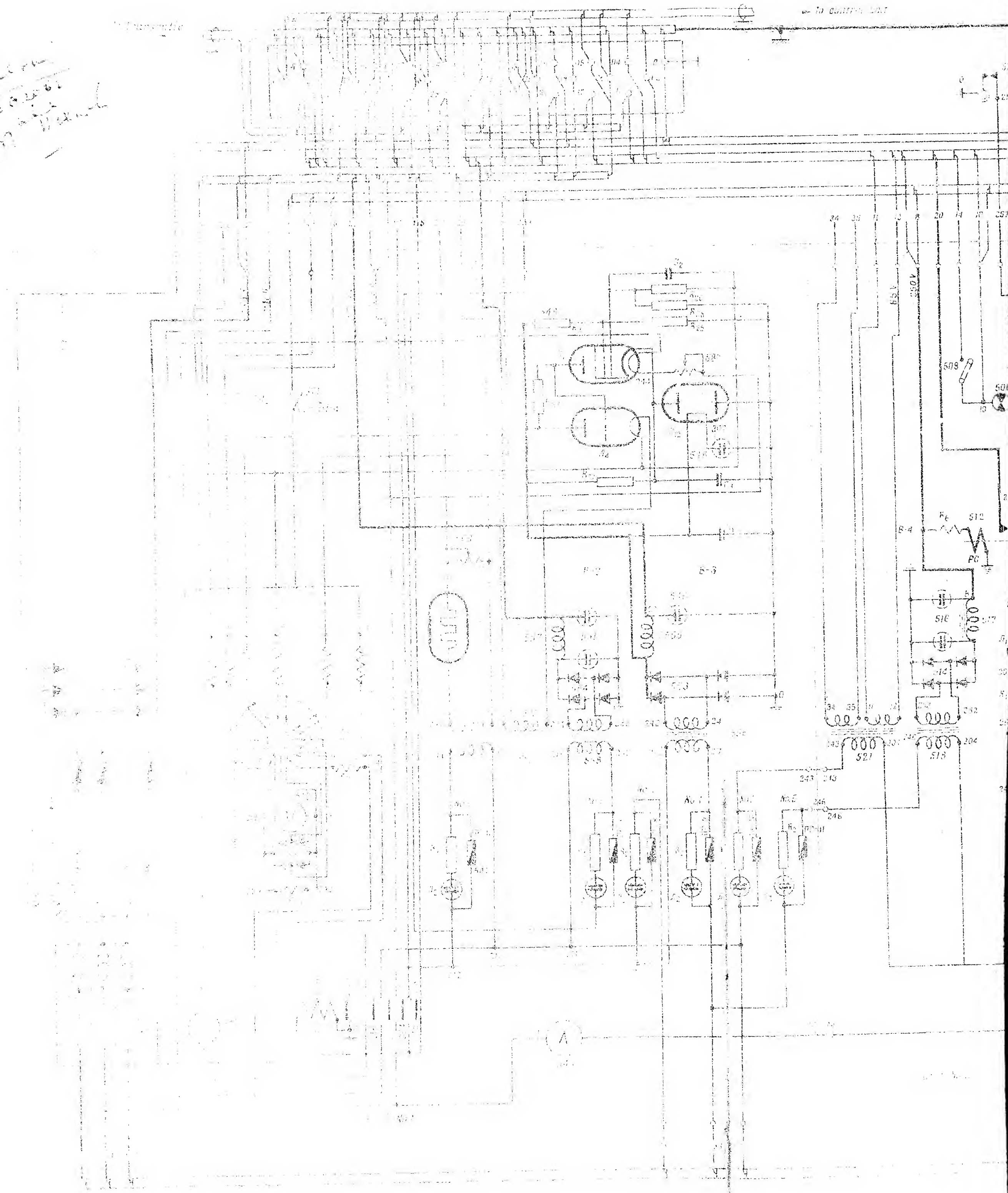


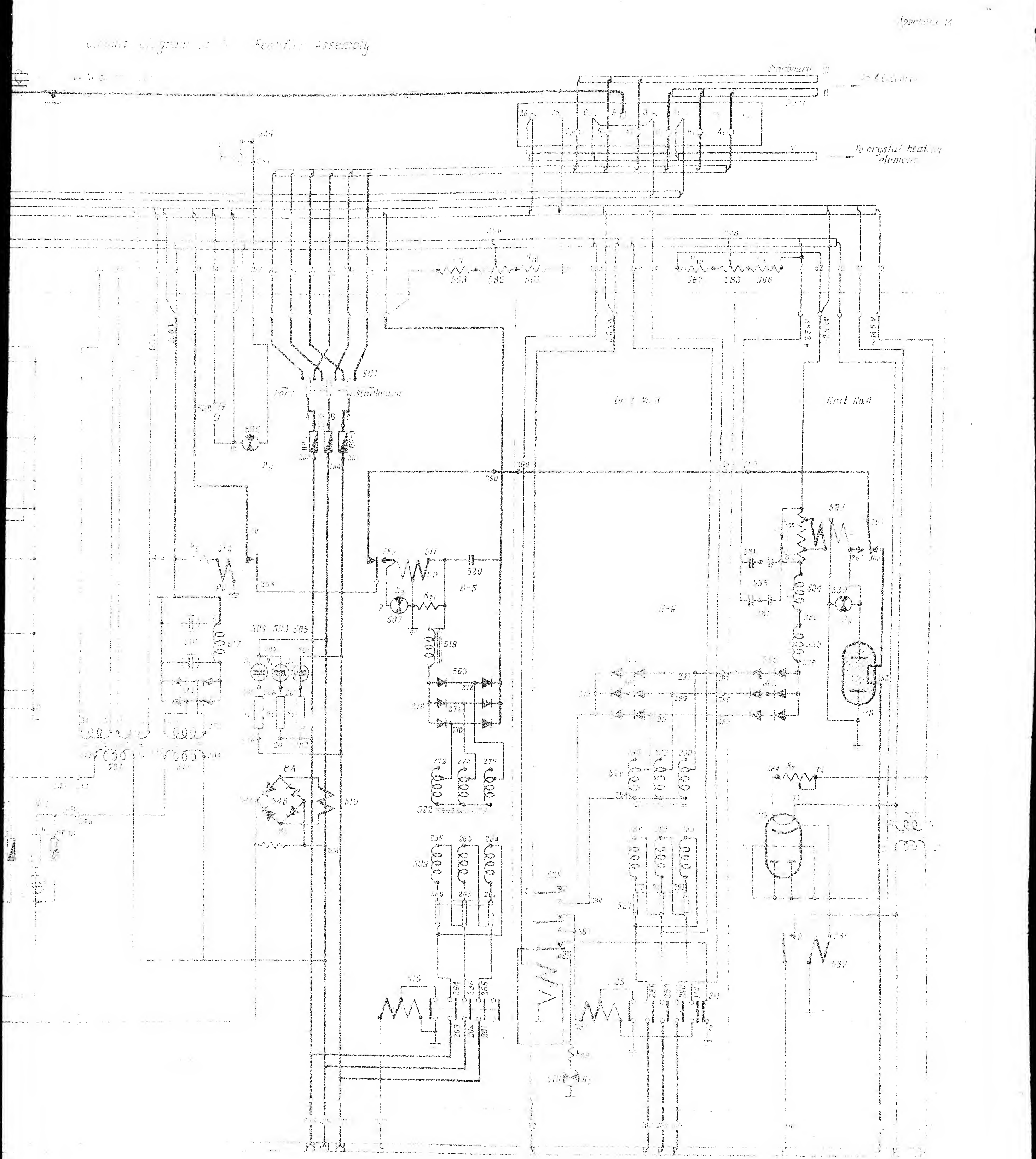
...ote Control Equipment

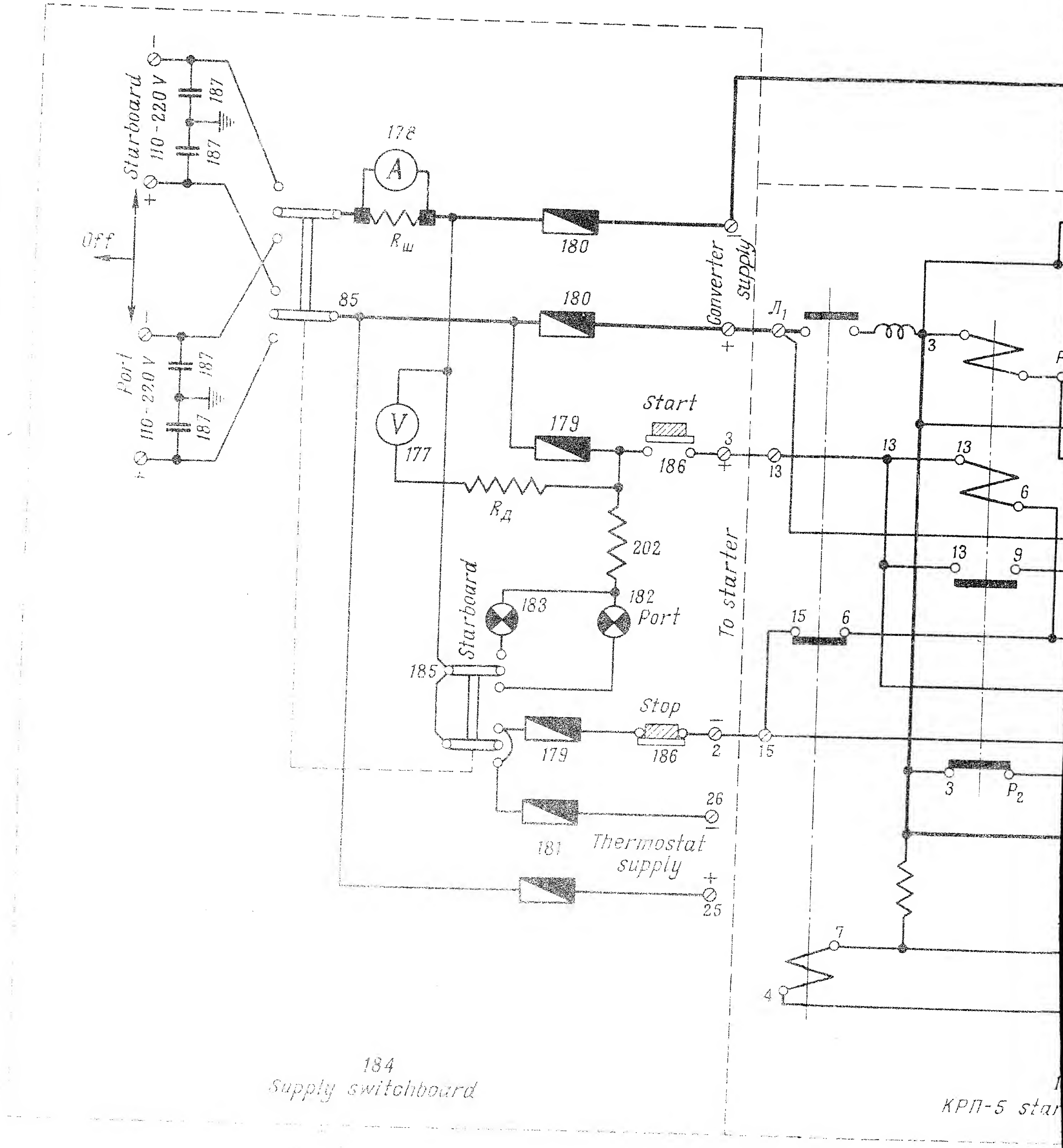


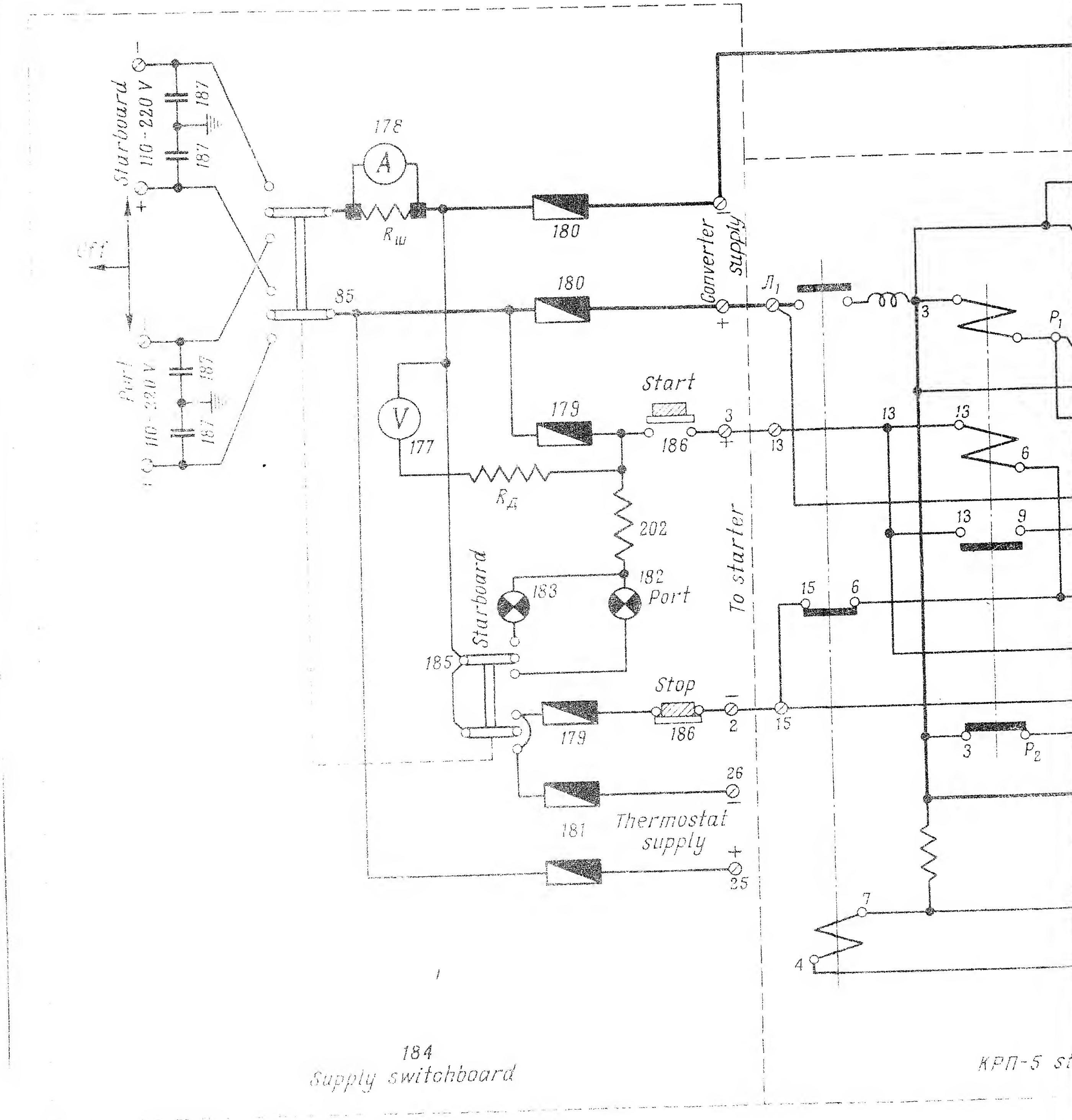


Circuit Diagram of ...

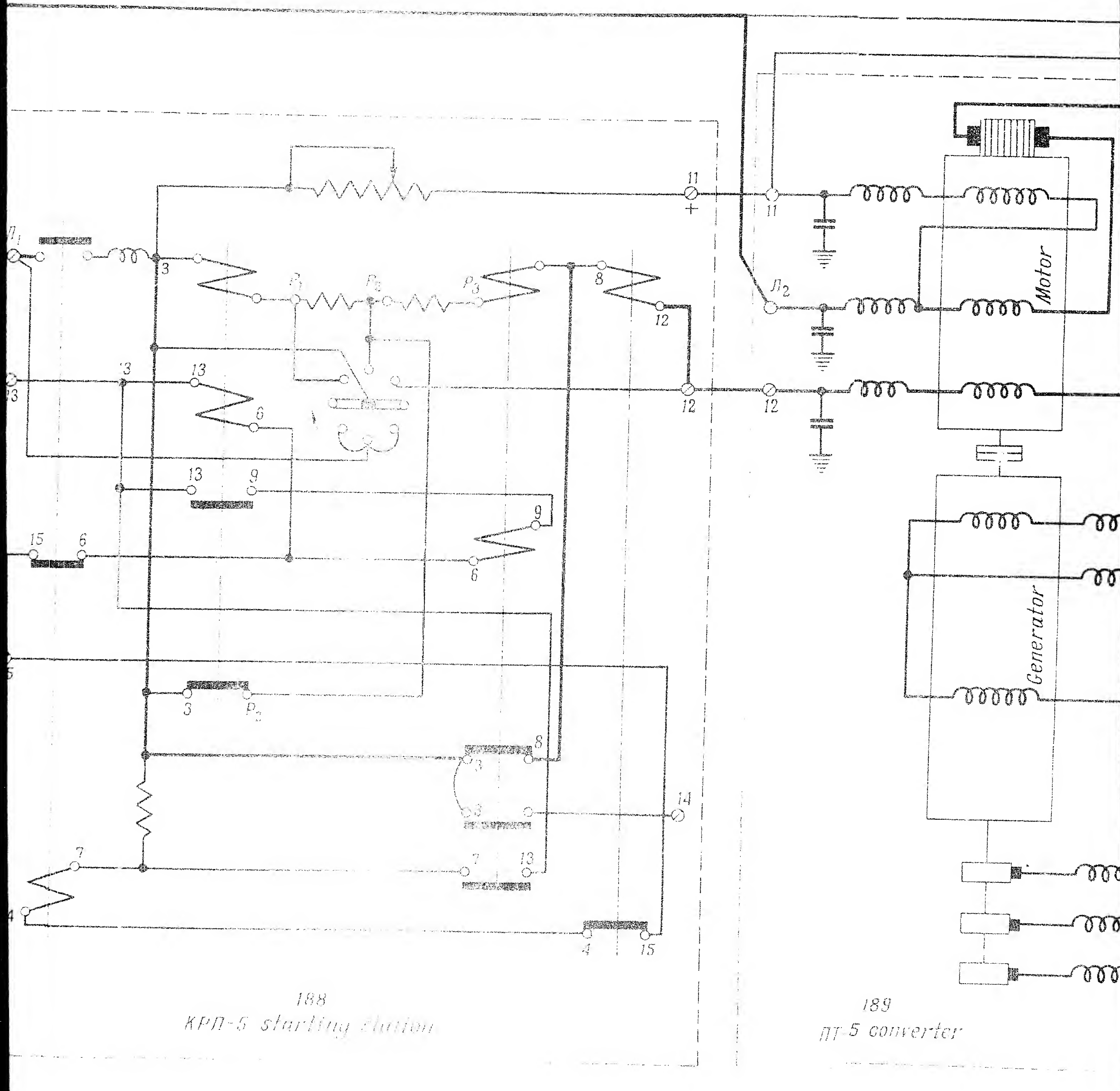


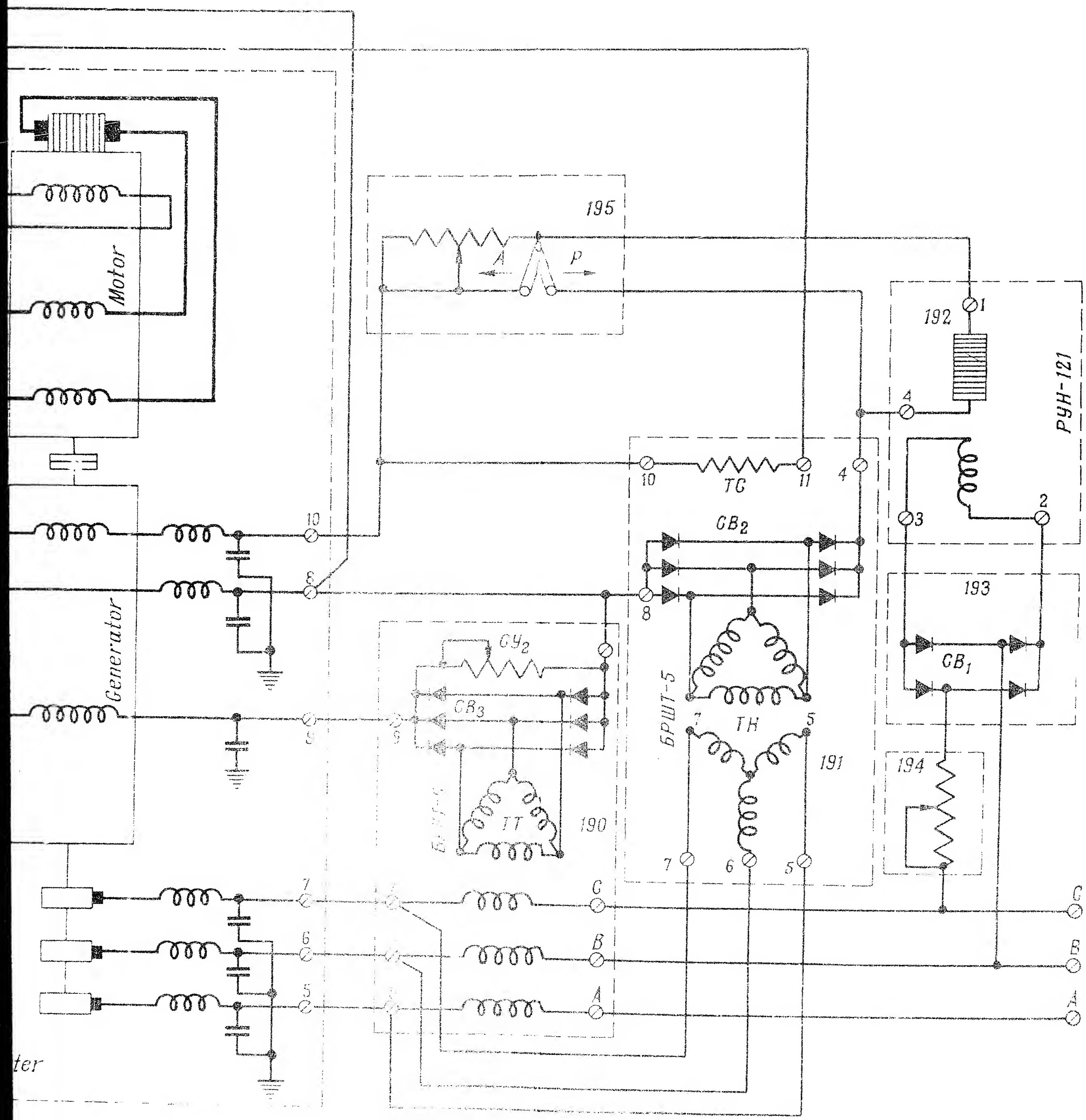

Starboard
Port
To crystal heating element
Port
Starboard
Unit No.3
Unit No.4

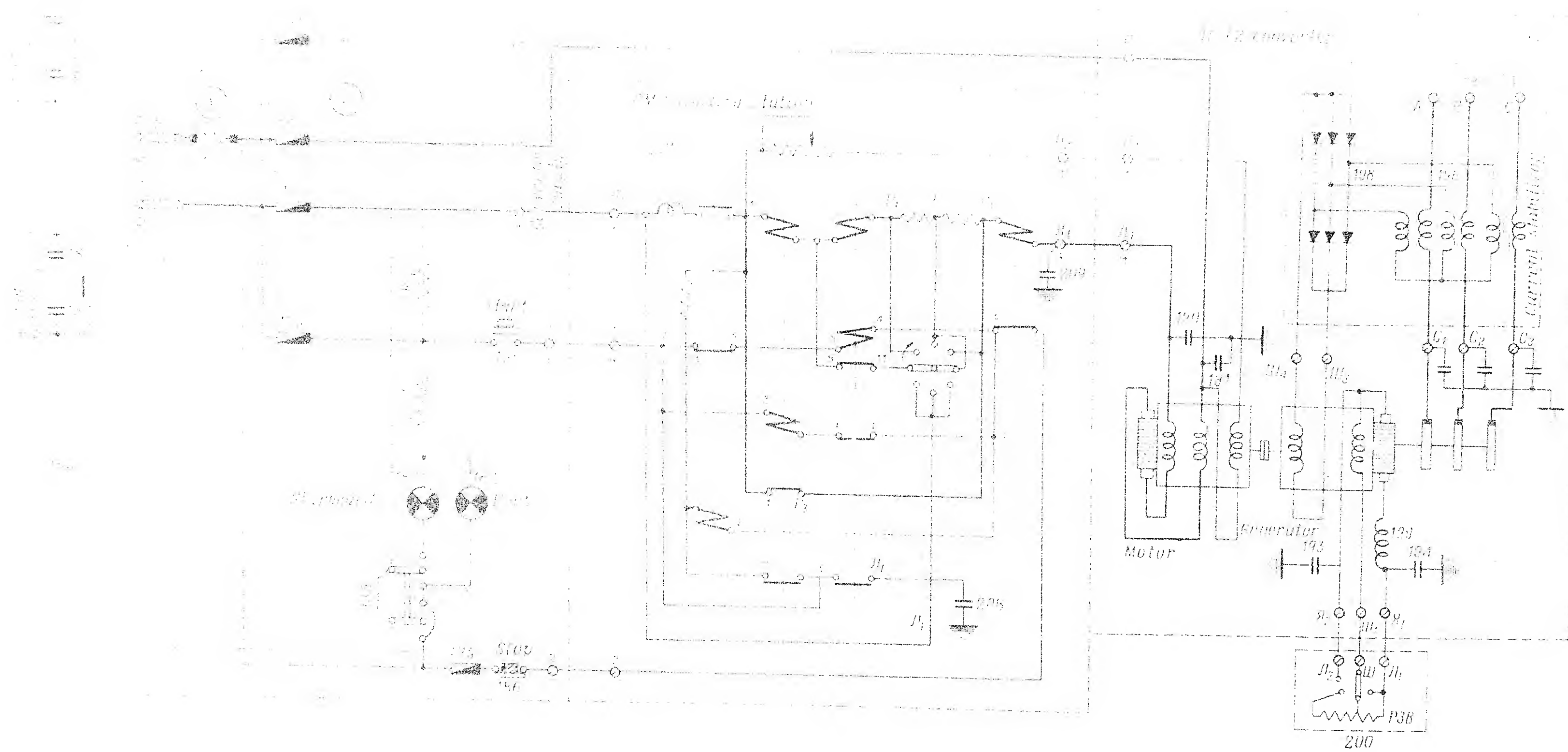

Starboard
110-220 V
187
178
A
Rш
180
Off
Converter supply
85
Port
110-220 V
Л1
V
177
179
Start
186
To starter
Rд
202
182
183
Port
Starboard
185
Stop
Thermostat supply
181
26
25
184
Supply switchboard
КРП-5 star


Starboard
110-220 V
187
Off
Port
110-220 V
178
A
$R_ш$
180
85
Converter supply
+
$Л_1$
3
P_1
V
177
179
Start
186
13
6
$R_Д$
202
9
183
182
Port
Starboard
To starter
15
185
Stop
2
P_2
26
181
Thermostat supply
25
7
4
184
Supply switchboard
КРП-5 st

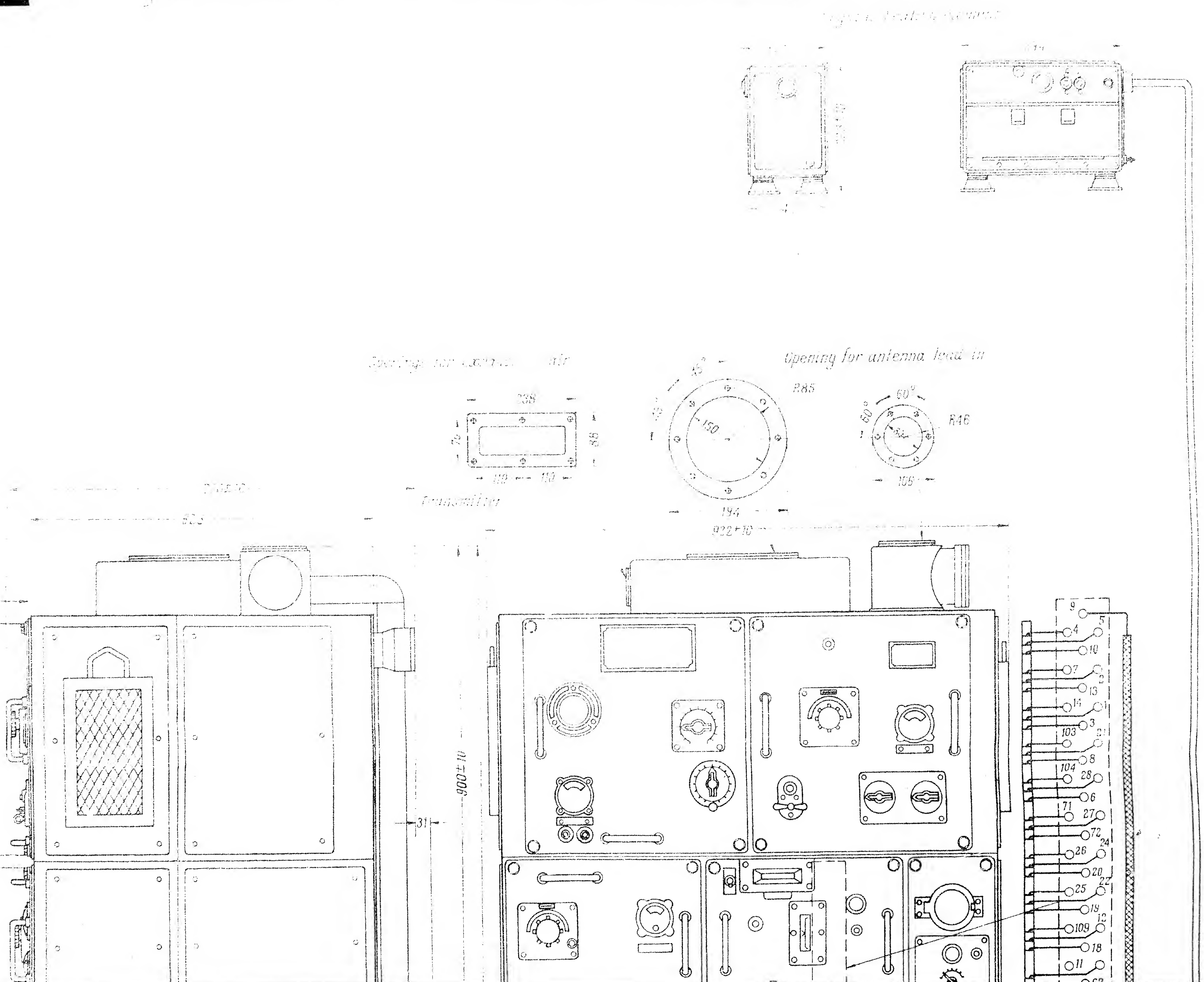
Circuit Diagram of ПТ-5 Converter with Control Equipment

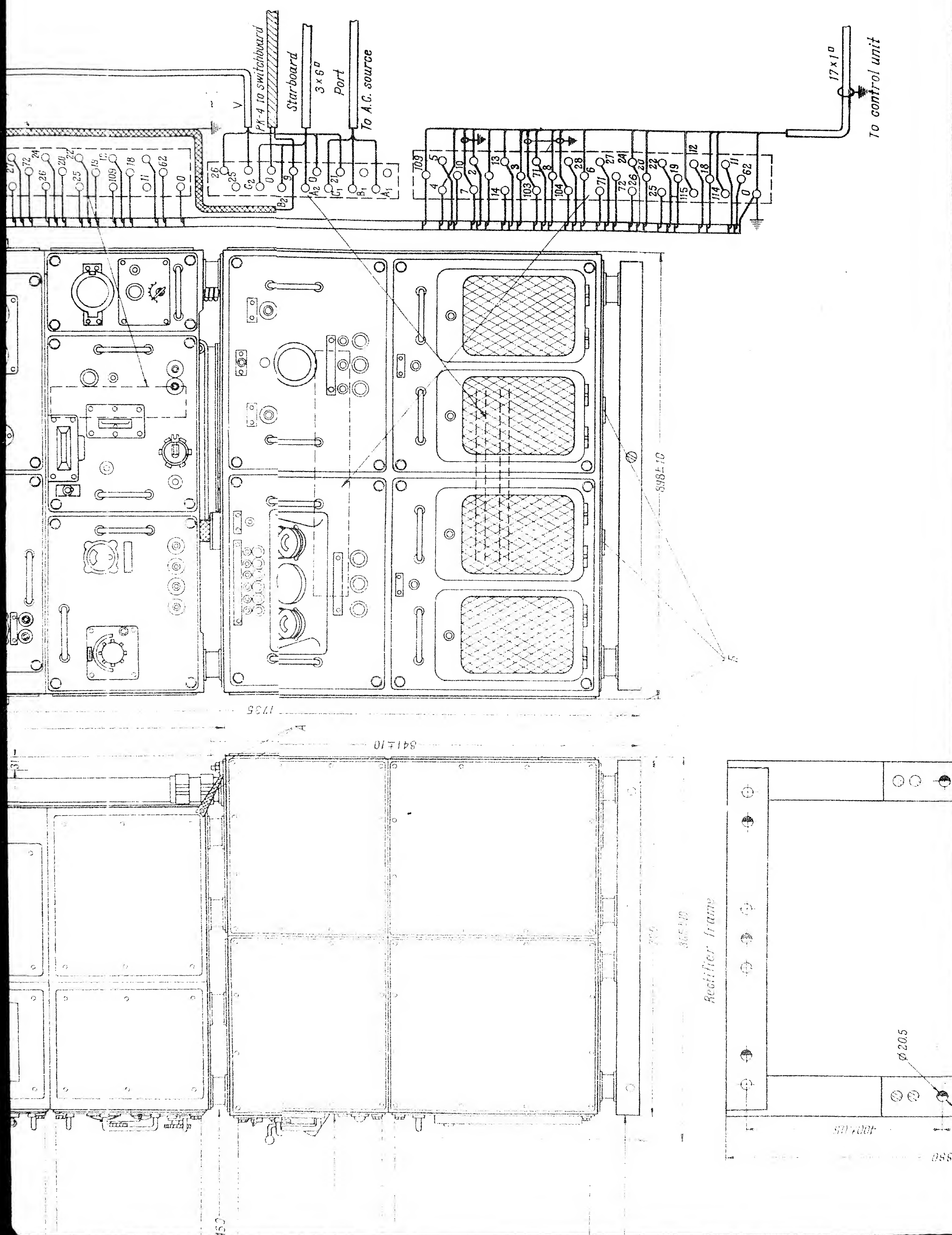


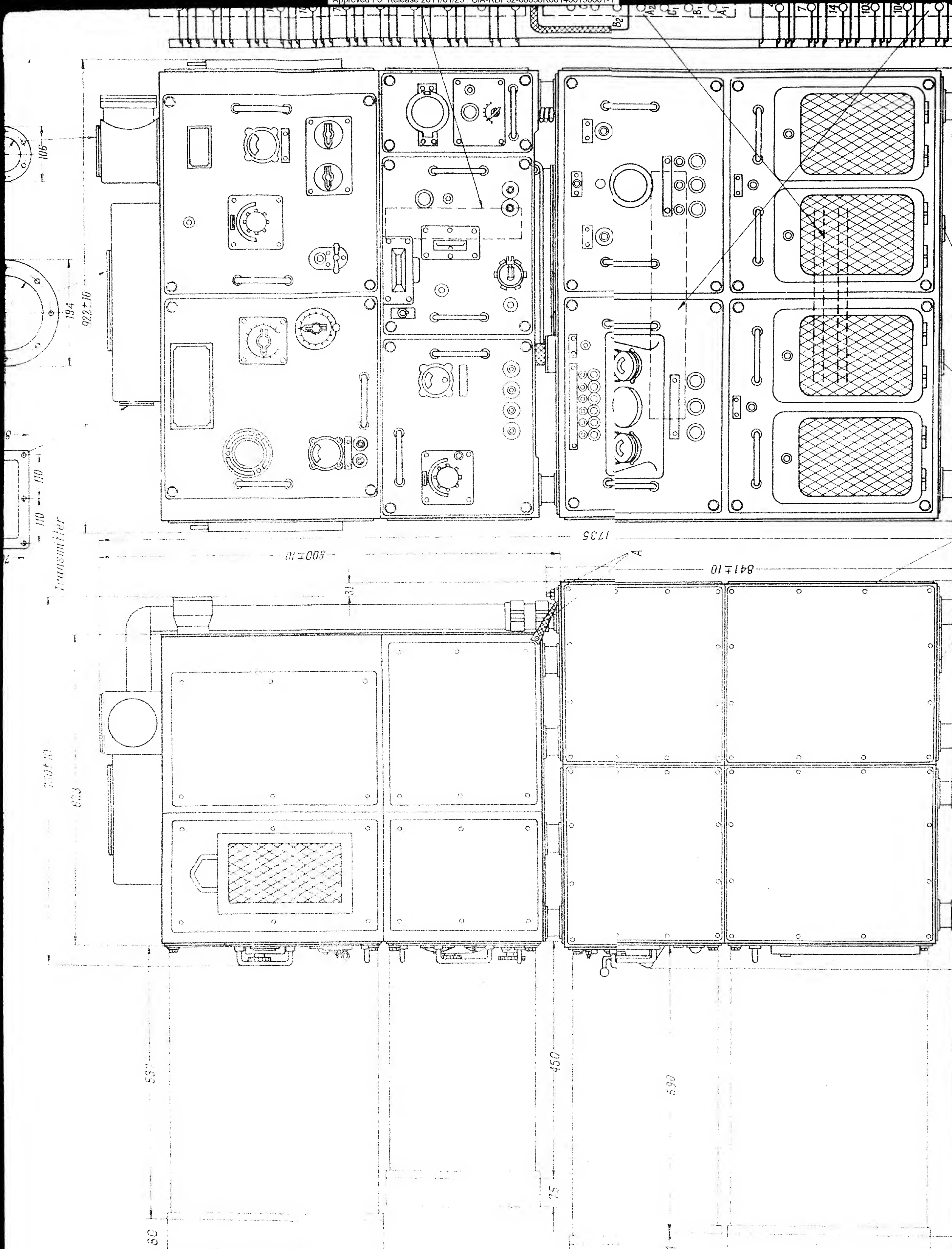

195
A
P
192
1
4
РУН-121
3
2
Motor
10
TG
11
4
CB2
10
8
8
193
CB1
Generator
GУ2
CB3
9
9
БРШТ-5
ТН
1
5
191
194
ТТ
190
7
6
5
7
6
5
C
B
A
C
B
A
~220 V
ter

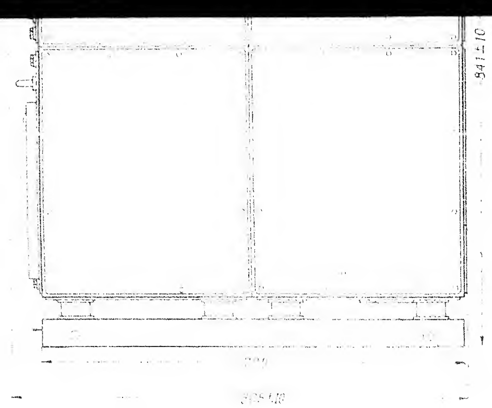

Motor
Generator
Current stabilizer
Starboard
Port
Stop
P3B
200

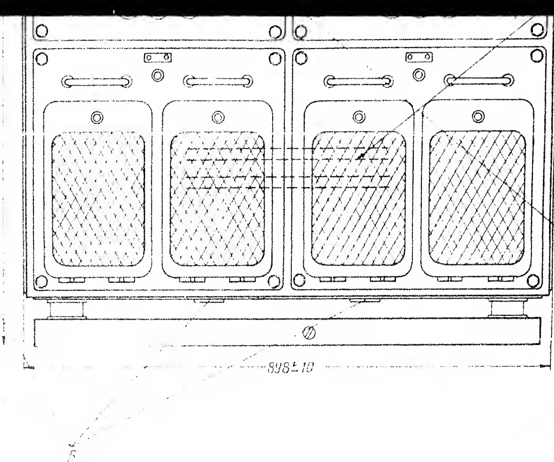
Appendix 17

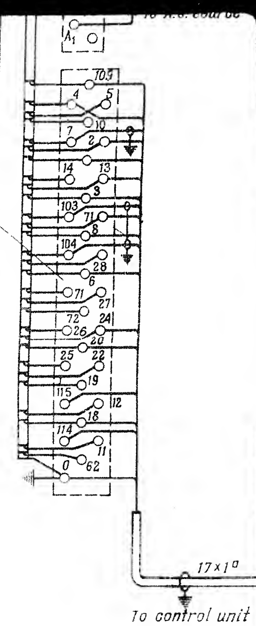

Opening for antenna lead in
R85
R46
150
194
922±10
238
105
900±10
31
9
5
4
10
7
14
103
3
8
104
28
6
71
27
72
24
26
20
25
22
19
109
18
11


PK-4 to switchboard
Starboard
3×6
Port
To A.C. source
17×1
To control unit
Rectifier frame
1735
841±10
598±10
ø 20.5
400±05
880

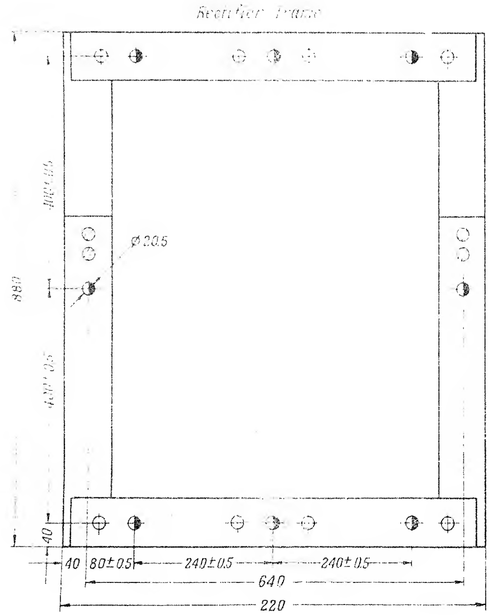

Transmitter
106
194
922±10
1735
500±10
841±10
31
537
450
590
75
80
74







Rectifier frame



A – connect body of transmitter with body of rectifier; connect rectifier to common earth busbar.

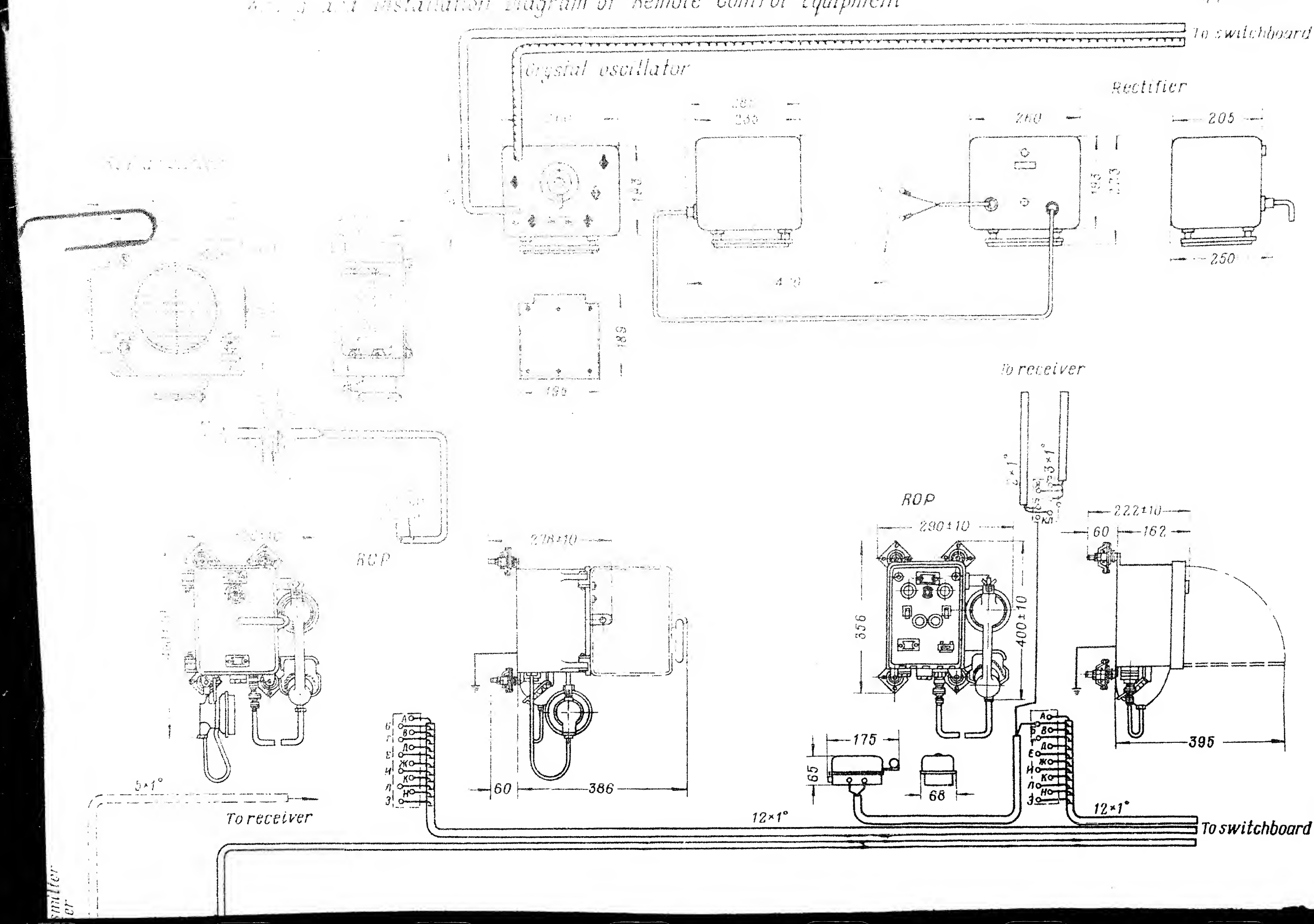
B – places for leading in cables I, II, III, IV and V and earthing busbar.

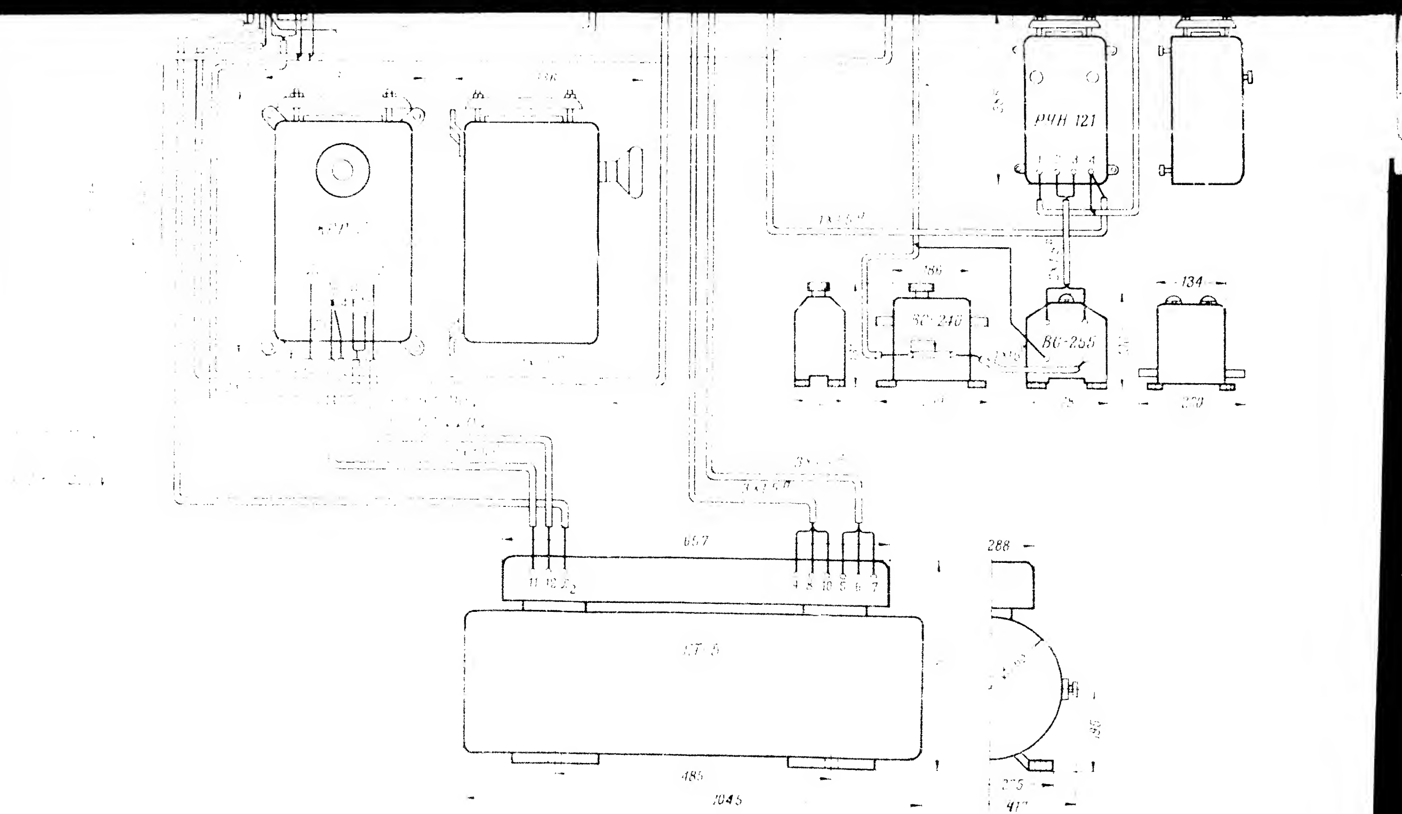
Note:

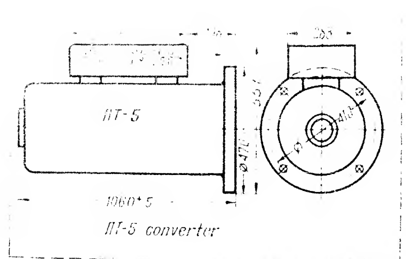
The cable to the crystal heating element is shown for an A.C. supply version. For a D.C. supply a two-conductor cable is used, which is connected to terminals 25 and 26

Installation Diagram of Remote Control Equipment

Appendix 18







Note:
In some radio stations the regulating units БРШТ-5 and БРКТ-5 are combined in the single unit БРПТ-5

Appendix 20

[illegible] Diagram [illegible] Power Unit with [illegible] Converter